THE ENGINEER.

Drilling and Boring Machines.

DRILLING AND BORING MACHINES.

It is only when the preparation of an article of this kind is begun that the endless variety of designs of drilling machines is fully appreciated. The lathe, the slotting machine, the planer, all present a certain stability of design, as if finality had been nearly reached. Not so the drilling machine. There are, it is true, certain elemental details which are common to all designs—the spindle sleeve, for example—but beyond that nearly every part seems capable of modification in some way or another. Sometimes the changes are clearly due to the necessity of meeting special conditions; at others the ideas of two designers find expression in very different products. We see an example of the first case in the means of carrying a radial arm. If the horizontal range over which the arm is required to swing is limited, then the vee slide in trunnions is adopted, whilst if the conditions impose the necessity of the arm ranging over the whole circle, then the central circular column and sleeve is used. Those are the two variations of one maker's designs. We may turn to another and find that he has found different solutions of the same problems. As an example of the embodiment of divergent ideas to meet the same end, we may direct attention to the changes in the radial arm itself. Everyone admits that with the increased pressures, due to augmented speeds and feeds, the necessity of obviating, in every way possible, the tendency to twist or spring must be satisfied. What shape, then, shall the arm be—and how shall the saddle be carried upon it? Most makers content themselves with bringing the spindle centre as close as the necessity of the design will permit to the face of the arm; another boldly meets the whole question of twist by making the spindle central. The grouping of the gearing on the saddle, the means of transmitting power from the first shaft, the position of the motor when used, the insistence on positive feed or the reverse, the use of collar or ball thrusts, the employment of solid or adjustable bearings, are all points on which there is, in a similar way, no little variety of practice.

Besides all these changes within certain recognised patterns, we have great varieties in the patterns themselves. Take the ordinary drill press alone, and see in the few examples it is possible to give in this Supplement how many changes are rung upon the fundamental design. One provides ball bearing thrusts, another uses thrust collars; one fixes the two spindle bearings, another puts the lower bearing on a slide; one provides positive, another belt feed, and so on. Thus, in a general review of the whole range of drilling machine design, we see constant changes and modifications of a type, and it is obvious to anyone who looks at these things philosophically that finality in the design of such machines is still far distant. The electric motor, the marine engine, the portable engine, have all ceased practically to vary. A few definite types meet all the requirements; evolution has ceased. The drilling machine, stimulated by the advances in the steel of which drills are made, has entered upon a new phase. At one time among the simplest machines in a shop, so simple that labourers were allowed to work them, drilling machines under the influences of the "feed and speed man" are fast becoming, nay, have become, little less complex in their structure than high-class modern lathes. It is no longer their duty to make a hole, they have to make it with precision; no longer is the speed of the spindle a matter of but little importance, it now must work at the best speed; no longer are three speeds and one or two belt feeds sufficient; eight, ten, nay even twenty-four speeds are provided, and the feed must be positive through gearing and instantly changeable from one rate to another. So the drill has advanced rapidly from the simple machine which satisfied us ten, and less than ten, years ago, to the highly finished complex and beautiful piece of mecharism which it now is. What advances may be yet before it who shall say? Have we reached the highest limits, have we even, as some say, passed the economical bounds, or are there still in front of us unimagined advances yet for a tool that was once the Cinderella of the machine shop?

We leave such pleasant considerations for those of a more practical nature, and enter upon the description of a few representative machines which will show

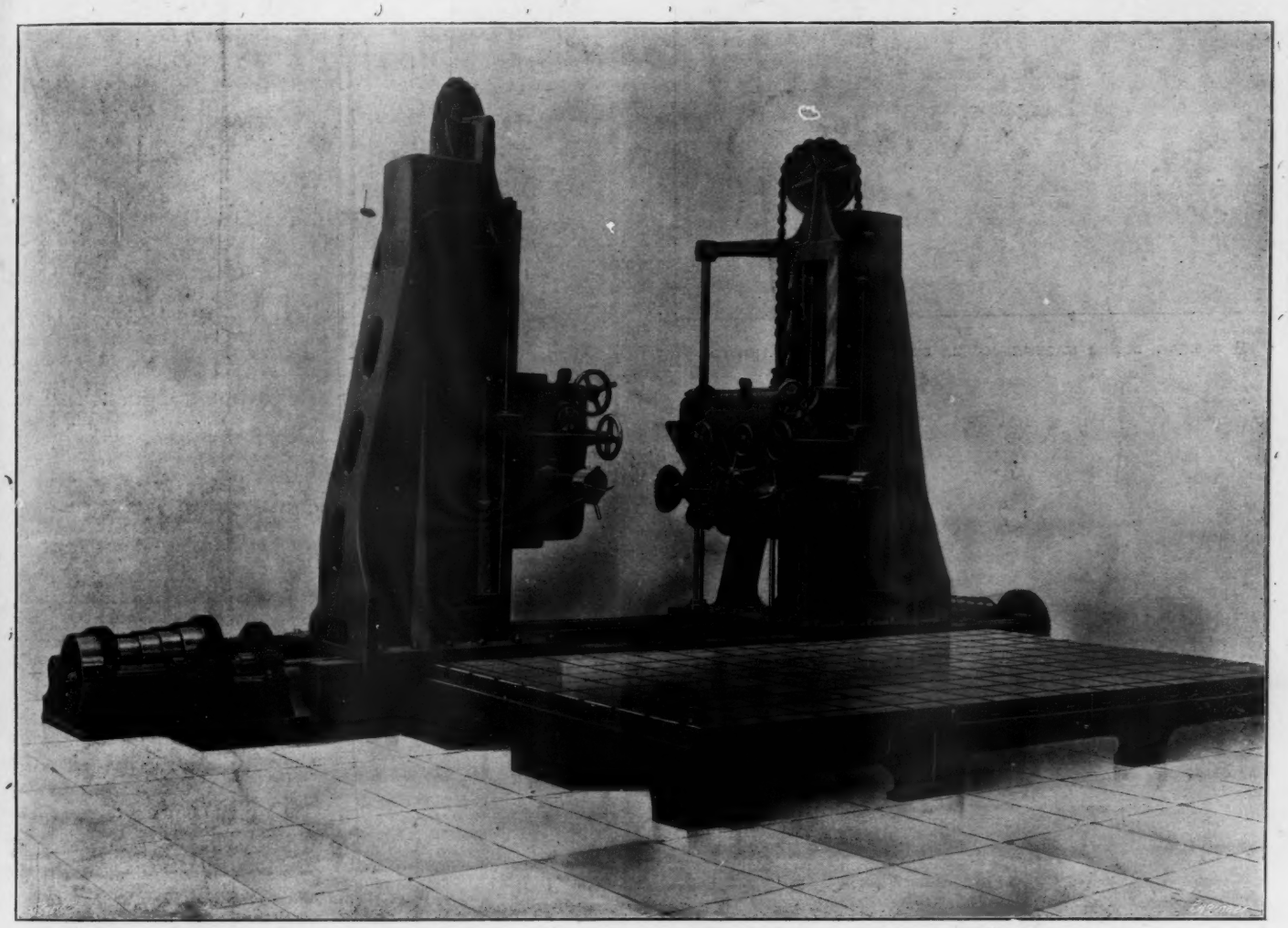


Fig. 1—DOUBLE COLUMN BORING AND DRILLING MACHINE—CAMPBELLS AND HUNTER, LIMITED

both the range and variety of products of this kind, and the high refinement that is now found in their parts and manufacture. We have, as on former occasions, to avoid misconceptions by stating that the arrangement neither follows an order of merit, nor of chronology, nor of anything else. A certain number of illustrations has to be included in the sixteen pages that make up this Supplement. The only consideration is to get those illustrations in; their shape and size influence the order in which they appear, and nothing else.

Amongst the most important of special machines are those that are used for the drilling, tapping, and staying of boilers. The machines are of various forms and designs, and many pages might be given up to illustrations of them. We have selected for description an excellent example of a machine of the kind only completed a few weeks ago by Campbells and Hunter, Limited, of Leeds, for the North-Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne. The type is a very popular one, and large numbers are made, either with one or two columns; hence it is a good representative of machines of its class. This machine, Fig. 3, is used on the drilling and the tapping of the holes, and the driving of stays up to 2in. diameter in marine boiler backs, and it goes through both shell and combustion chamber plates at once. It is also employed in tapping stay tube holes up to 4in. diameter, and driving the stays.

It has spindles 3½in. diameter fitted with self-acting and hand-feed motion operated by rack and pinion and giving a travel of 2ft. 6in.; it has two speeds for drilling and tapping, and a clutch releasing and reversing motion. The saddles are balanced, and have a rising and falling motion actuated by hand or power through rack and pinion, of no less than 13ft., and a canting motion to accommodate the spindles combustion chamber plates. The swivelling of the saddles is controlled automatically by the rising and lowering gear, so that in whatever position the spindle may be it points positively to the centre of the boiler under operation; for drilling side stay holes the spindle accommodates itself by means of change wheels to different diameters of boilers.

Each column has a transverse horizontal motion of 17ft, self-acting both ways by means of rack and pinion, the motion being controlled from the saddle, and it stands upon four runners, so that it may be easily moved along the bed. Each column is driven separately by an electric motor, and is fitted with a platform secured to the saddle. The total weight is about 25⅓ tons.

Another fine machine constructed by Campbells and Hunter is also illustrated—Fig. 1. It is a double column horizontal boring, drilling, and reaming machine for general marine work, and especially for drilling and reaming the holes in the couplings of large tunnel shafts. The actual machine shown is now at the works of William Doxford and Sons, Limited, of Sunderland.

The columns, it will be seen, are arranged right and left hand to face one another, so that the spindle may be brought fairly close together. The minimum horizontal distance between them is 11ft. 6in.

Each saddle has a travel on the column of 5ft. by hand or power, and is balanced. The spindles are 5in. diameter, with a variable self-acting and hand feed by rack for quick withdrawal of 2ft. 6in., and are fitted with locking arrangement to prevent backlash. There are sixteen positive changes of feed. The fast and slow motions for drilling and tapping, the reversing motions to the spindles, and the self-acting motions and hand motions for raising and lowering the saddles on the columns, are all carried on the saddles.

The columns have each a power motion at a speed of 9ft. per minute upon the bed. The bed is 21ft. long by 5ft. 6in. wide, and carries a driving gear at each end for the separate shafts, so that either column can work independently at any part of the bed. Two compound stays, having a vertical adjustment of 5ft. by screw, and horizontal motion, also by screw, are provided for use when boring. The machine is driven by two overhead motions through four step cones of large diameter. The total weight is about 47 tons.

A boring machine that differs in a very pronounced way from any others illustrated in this Supplement is that shown in Fig. 2, and made by Joshua Buckton and Co., Limited, of Leeds. It is, from its peculiar construction, known as a snout boring machine, and has several strong points in its favour. In most bar-boring machines the cutting tool must, from the nature of the design, vary its position constantly with relation to its supports. It begins, for example, near the headstock, where it is well supported by a bearing quite close to it; it is fed forward, until at half-way through its work it is equally distant from both the steady and the headstock. Then, as it continues, it gains more and more support from the steady as it approaches it. The result is that the tool springs more in the central region than at the ends, and perfect parallelism is impossible, although it may be very closely approached by using a stiff bar and a fine feed. This variability of support can, of course, be overcome by causing the bar to be rigidly carried at both ends, and moving the work along it, or the case can be met by mounting the cutting tool at the end of a long and stiff sleeve, and either feeding the work or the sleeve and cutter. The former is the plan usually adopted, and is illustrated by the snout machine in question. Besides equalising the spring all through, this design has the further advantage that, as no through boring bar is required, a cylinder, for example, may be bored up to a dead end. The illustration is practically self-explanatory. The

Fig. 2—SNOUT BORING MACHINE—JOSHUA BUCKTON AND CO., LIMITED

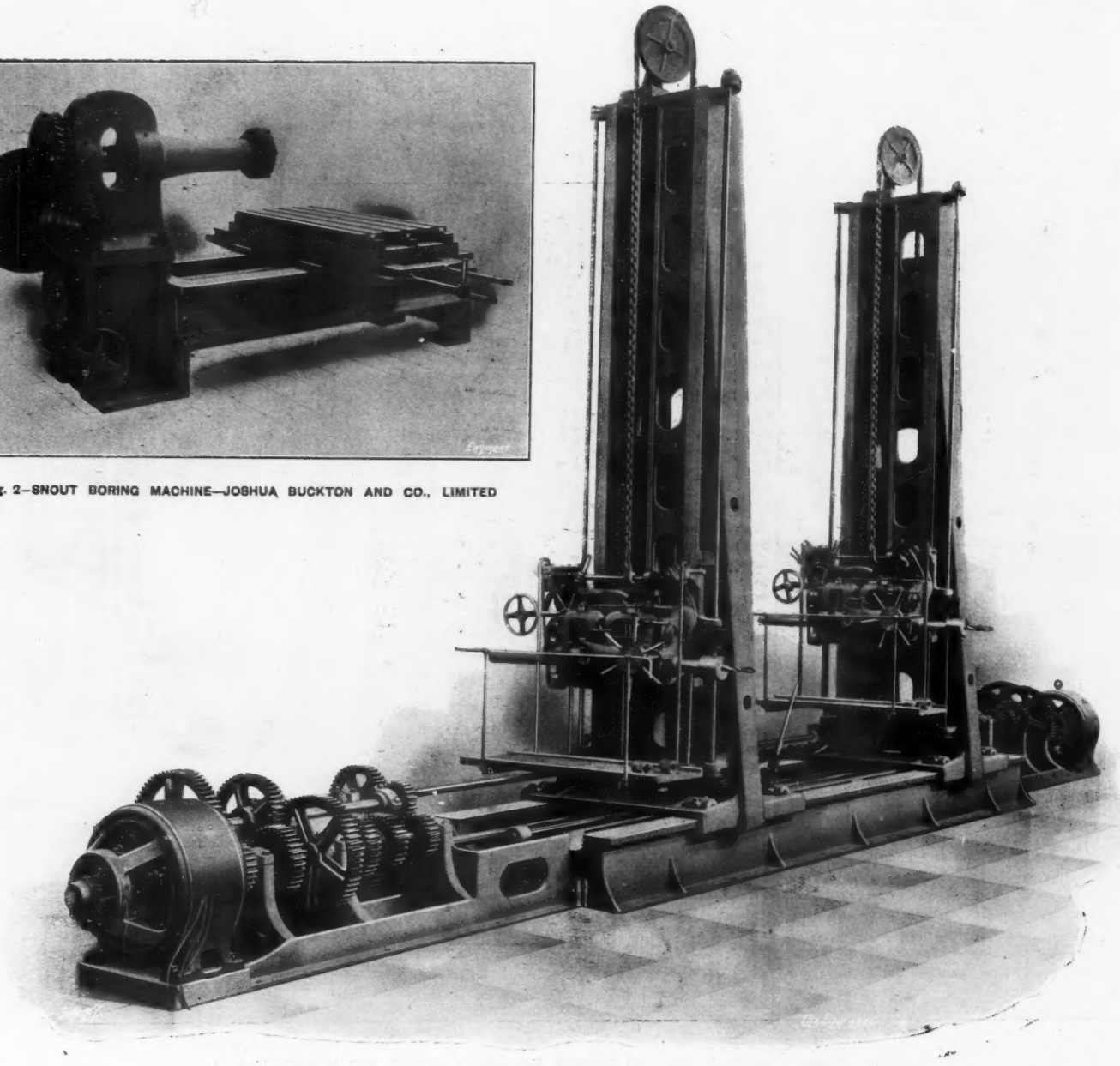


Fig. 3—MARINE BOILER DRILLING MACHINE—CAMPBELLS AND HUNTER, LIMITED

main driving cone is on the far side, the cones on the near side being for the feed. In both cases a worm and wheel are employed for speed reduction.

We illustrate also several designs of radial drills made by Bucktons. All these drills are intended to face the increased speeds and feeds which the introduction of high-speed steel has brought about. The radial arms are all made of completely closed box section—a form which is recognised as possessing a very high resistance to torsion—and the centre of the drill spindle is brought as close as may be to the face. The drawing of a drill head showing section of the arm—Fig. 4—brings out both points clearly. The machines shown are all designed to be driven by a constant speed pulley, the changes of speed being obtained through a gear box—of which a section is given, Fig. 5—and the feeds being varied by gear on the saddle.

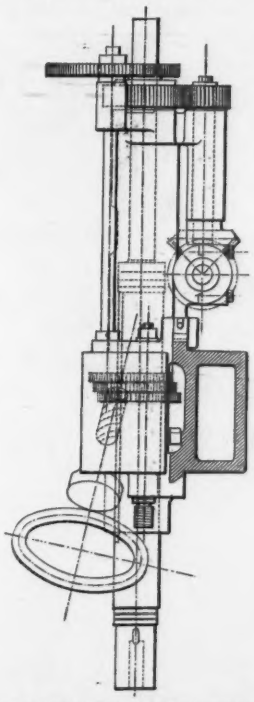


Fig. 4—BUCKTON DRILL SPINDLE

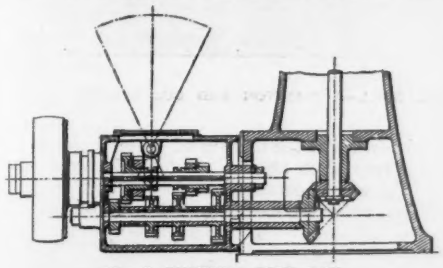


Fig. 5—BUCKTON GEAR BOX

Fig. 8 shows one member of a set of five 6ft. radials with spindles 3¼in. diameter. The tubular form of the saddle and the powerful cradle upon which the arm can be moved by power may be specially observed. The trunnions for this cradle are as far apart as the size of the machine will permit, and the weight is carried upon a ball race. The feed is by rack and spiral pinion—practically the Sellers gear—which gives a very smooth and easy motion.

A smaller machine—5ft. radius—is shown by Fig. 9. It has a close resemblance to the larger size, but the method of carrying the arm is different, and permits of its being swung through a complete circle. A third drilling machine, Fig. 10, has a curious feature. It is similar to Fig. 9, and is driven in the same way, but the main arm carries two auxiliary jibs, upon which are adjustable the two drilling saddles in a direction at right angles to the face of the main arm. Thus each spindle has two independent straight line adjustments, and each can be manipulated independently of the other, rendering it possible to drill simultaneously in a piece of work two holes, no matter how irregularly placed, if they fall within the limits of the machine. The position of the spindles is such that they may be brought remarkably close together.

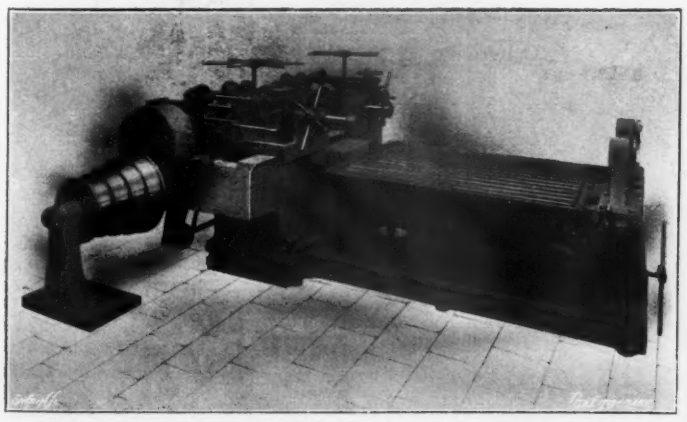


Fig. 6—HORIZONTAL DRILLING MACHINE—NOBLE AND LUND

The duplex vertical drilling machine, Fig. 11, by Noble and Lund, of Felling-on-Tyne, differs from other double-spindle machines illustrated in having the table divided centrally, so that to all intents and purposes two separate machines are provided. The machine could, however, be operated by one man without offending the susceptibilities of the tenderest trade union. When desired, the tables can be joined together and used as one.

The drilling heads are fitted with steel spindles 3in. diameter, with a self-acting or hand vertical traverse of 12in., they are balanced and can be raised quickly. There is a two-speed change on the spindle, giving with the four step cones the following eight rates of revolution of the spindle, the countershaft making 160 turns per minute:—20, 32, 40, 50, 60, 100, and 150. The heads are also fitted with reversing motion and clutch for tapping, which can also be used to stop either spindle. The gearing throughout is of steel cut from the solid. Each part of the table is 2ft. 9in. by 3ft., and can be moved in and out by worm and rack motion. The distance between the columns is 7ft. 6in., the minimum distance between spindle centres 9in., and the maximum 6ft. 3in.

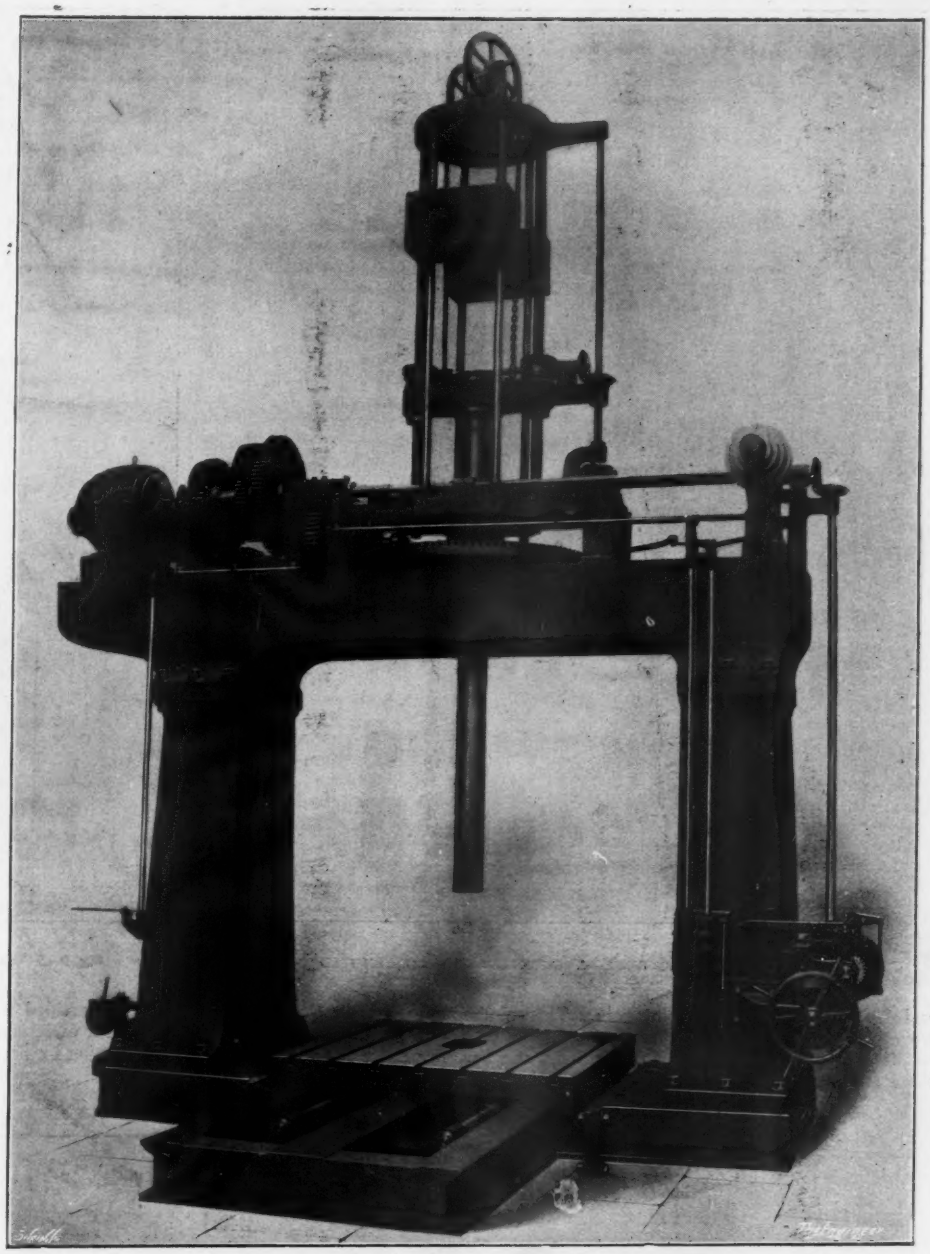


Fig. 7—VERTICAL BORING MACHINE—HULSE AND CO. LIMITED

A useful two-spindle drilling and boring machine also by Noble and Lund is illustrated by Fig. 6. It has been designed especially for marine engine builders, and primarily for drilling and boring the two holes simultaneously in the big ends of connecting-rods, but there are obviously many other uses to which machines of the type may be put.

The two spindles are driven by one four-step cone, but in other respects they are quite independent of each other, having separate feed traverse, &c. The heads are moved along the bed by star handles accessible from the front of the machine, so that the operator may see what he is doing whilst adjusting his work, but further to assist him steel rules with pointers are fitted to the drill heads and the steady brackets. The table can be raised by hand or power, and is well guided at each end by vee slides.

The spindles of this machine are 4in. diameter, and they can be brought to within 9in. of each other. The machine is geared to be able to drill two 4in. holes out of solid steel simultaneously.

A very large boring machine of the vertical type is shown above, Fig. 7. It was recently completed by Hulse and Co., Limited, of Manchester, for

a large firm of marine engine builders, and is suitable for boring cylinders, propeller bosses, crank webs, &c. An idea of its dimensions may be gathered from the fact that it will admit 12ft. between the uprights, and 10ft. 6in. under the cross beam. The spindle has a diameter of 10in. and a traverse of 7ft. The bed is of box section, it is about 16ft. long, and has three wide flat bearing surfaces on which the table rests. This table is 8ft. square, has planed tee grooves, and quick power and hand traverse motions by means of twin screws and bevel gearing. The driving tube or sleeve is rotated by machine cut bevel gears, and has three positive changes of speed, whilst the speed of the 20 brake horse-power motor, which drives it, is variable between 300 and 900 revolutions per minute. The spindle is over 14ft. long, has a thrust bearing, and is provided with quick power traverse up and down, with variable and reversible self-acting and hand-feed motion for boring up to 7ft. in length.

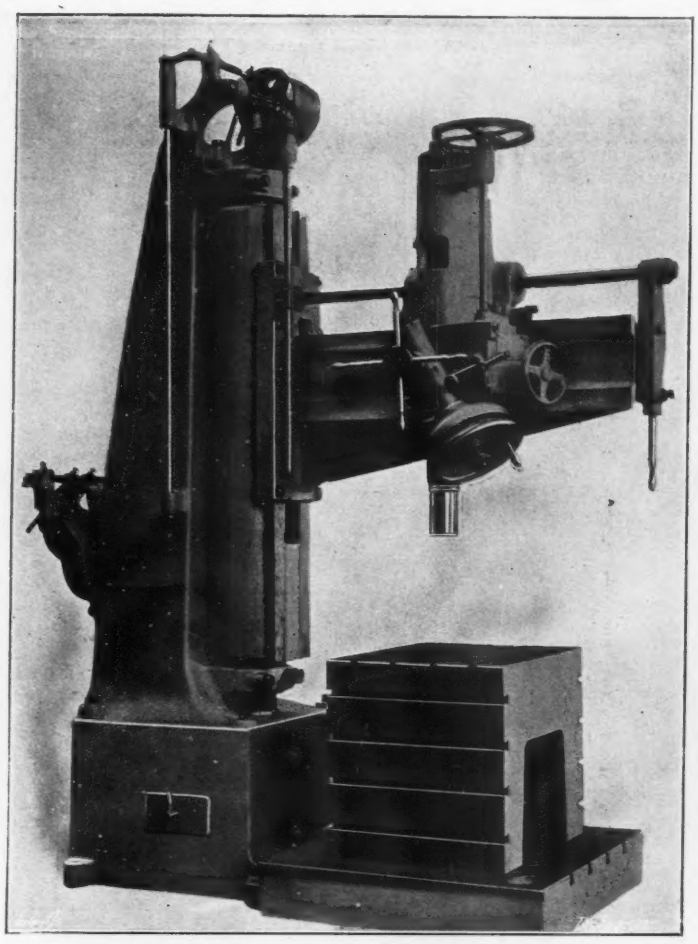


Fig. 8—6-FOOT RADIAL DRILL—J. BUCKTON AND CO., LIMITED

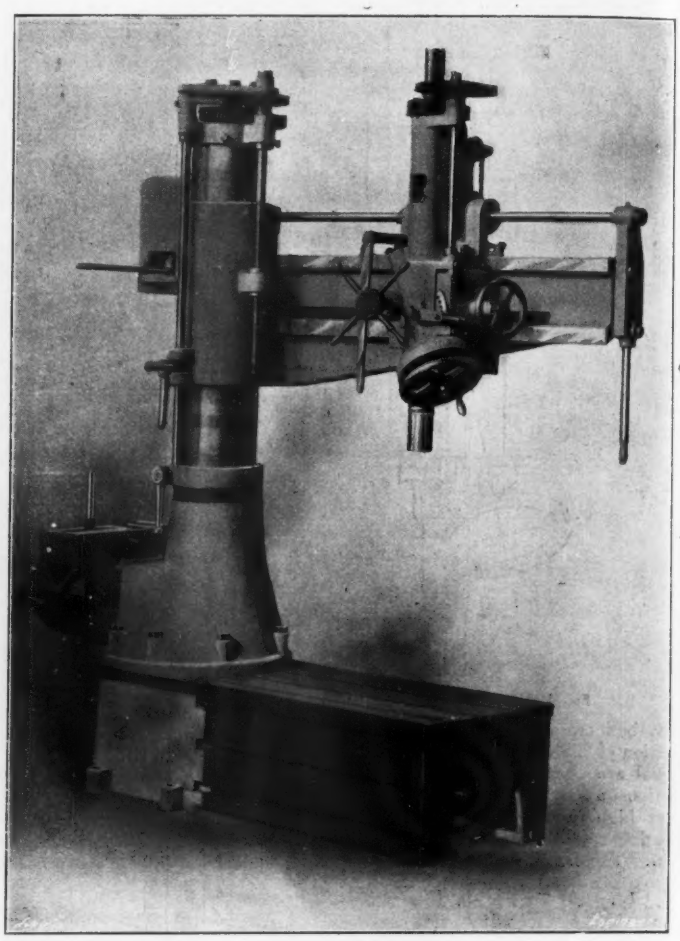


Fig. 9—5-FOOT RADIAL DRILL—J. BUCKTON AND CO., LIMITED

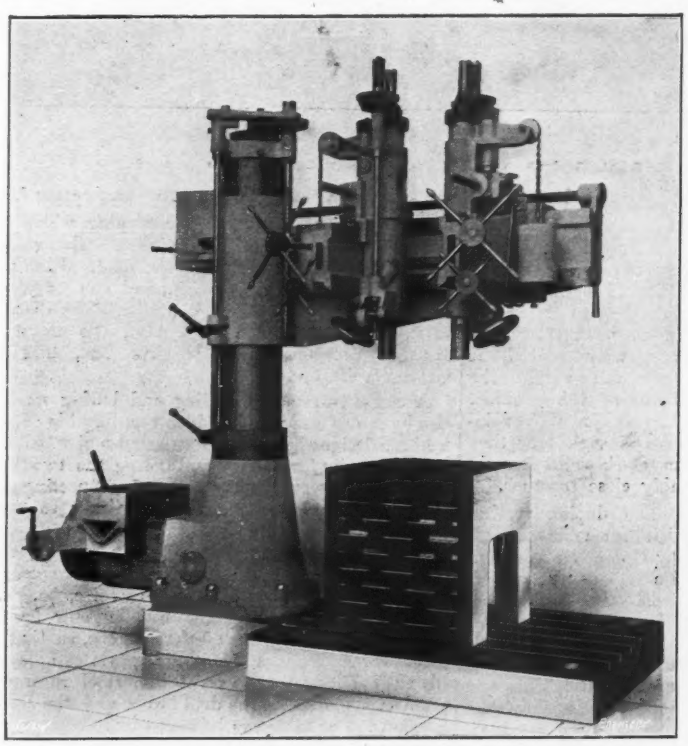


Fig. 10—TWO-SPINDLE RADIAL DRILL—J. BUCKTON AND CO., LIMITED

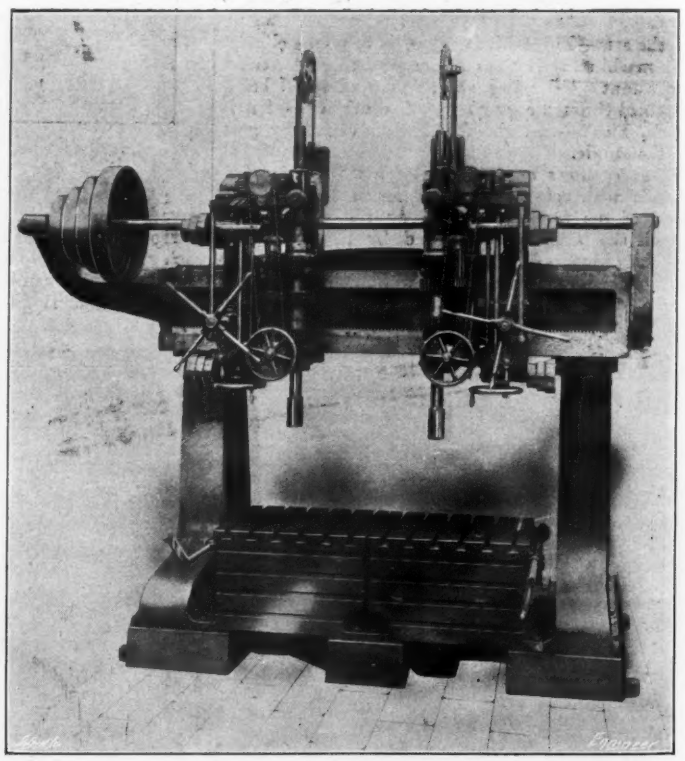


Fig. 11—DUPLEX DRILLING MACHINE—NOBLE AND LUND

The special feature of Kendall and Gent's direct electrically-driven radial drilling and tapping machine with two spindles is the mounting of the driving motor on the saddle carrying the spindle. This arrangement is found to be very economical where electric current is available, as it dispenses with a considerable number of wheels, shafts, &c., and consequent loss of power. It is well known that the driving of these shafts at high speeds very often absorbs considerably more power than the actual cutting, even when such shafts are working under the most favourable conditions.

The machine illustrated by Fig. 12 is driven by a 7 horse-power motor, and will drill and tap up to a maximum radius of 6ft. It is capable of working high-speed drills up to 2in. diameter to their maximum feed

and speed, and is fitted with suitable gearing for tapping holes of corresponding sizes without change of speeds, the ratio between the drilling and tapping spindles being four to one. The object of using two spindles is to save the change from drill to tap. The drill is carried in the front spindle, the tap in the other. The hole being drilled, the carriage is run forward, and the tap brought instantly into action.

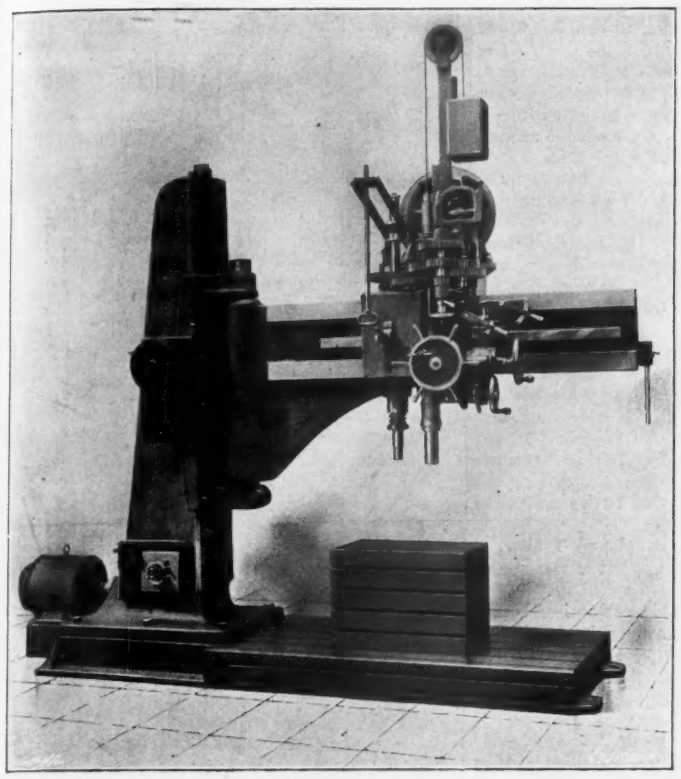


Fig. 12—DRILLING AND TAPPING MACHINE—KENDALL AND GENT, LIMITED

The boiler shell drilling machine made by Kendall and Gent, and illustrated by Fig. 38, page xii., is made under the patents of the late Mr. Dixon. The aim of the design is to reduce labour costs on drilling boiler shells by arranging that all operations shall be controlled by one operator on the starting platform.

The machine consists of a bed of strong section for the reception of the sliding uprights, and provided at the centre with a circular bearing for the stem of the circular table or chuck on which the boiler rests. This chuck, which is carried on a ball bearing at its centre and on rollers near its periphery, is rotated by means of a worm wheel and worm, by which dividing for the pitch of rivet holes is effected. It is provided with five gripping jaws moved simultaneously by means of a central bevel wheel gearing with pinions on the jaw screws. A similar set of wheel and pinions is provided at the upper end of the holder-up when required, by which the boiler is also concentrically gripped and supported at some distance from the chuck. The boiler, being thus rigidly secured and capable of rotation for dividing, the drilling is performed by the spindles carried on the saddles sliding on the uprights.

It will be noticed that on the left-hand upright two saddles are mounted, each carrying two spindles. The upper and lower spindles, respectively, of these saddles are carried in a head or bracket, which in turn is mounted on a slide at right angles to the face of the upright. All four spindles can be set in line vertically for drilling four holes simultaneously in a vertical or longitudinal seam. The upper and lower spindles can also be swivelled in a horizontal plane, enabling them to be set radially to the centre of the shell when drilling circular seams. In the same manner the two spindles on the right-hand upright can be set to work on two holes on the other side of the ring, and thus four holes can be drilled simultaneously, as in the case of the vertical seams.

The feature of the machine, however, lies in the arrangement of the feeding mechanism to the spindles, the effect of which is that the operator can advance simultaneously all the spindles at the feeding rate, and after drilling through the plates the spindles can then be simultaneously withdrawn positively at a quick rate until clear of the plate, when the boiler ring or shell is rotated a definite amount by means of the dividing gear, and a fresh series of holes drilled. The means by which the withdrawal of the spindles is effected are these:—Each spindle is provided at its outer end with a screwed prolongation which passes through a correspondingly tapped nut formed in the boss of a small steel spur pinion. Alongside this pinion is a similar one splined to the screwed portion of the spindle, and containing one tooth less than the first one; both these pinions gear with a small wheel carried on a short side shaft. There is thus a retardation of the nutted pinion at each revolution of the screw, and the spindle is thus fed forward. To withdraw the spindles when the holes are drilled through the plates their direction of rotation is reversed.

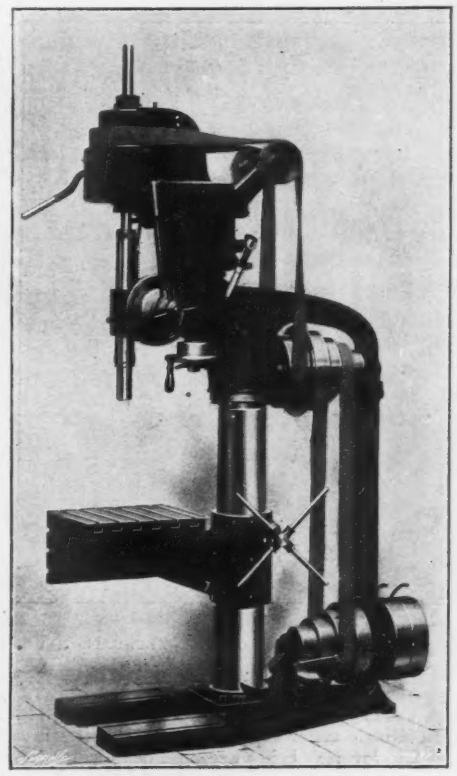


Fig. 15—HIGH-SPEED DRILL—ARCHDALE AND CO.

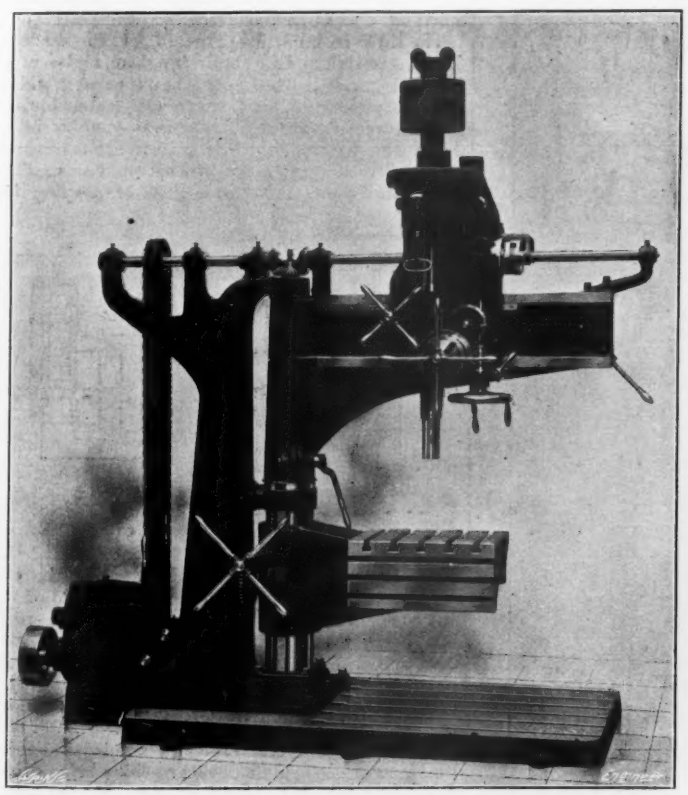


Fig. 13—3-FOOT 6-INCH RADIAL—ARCHDALE AND CO., LIMITED

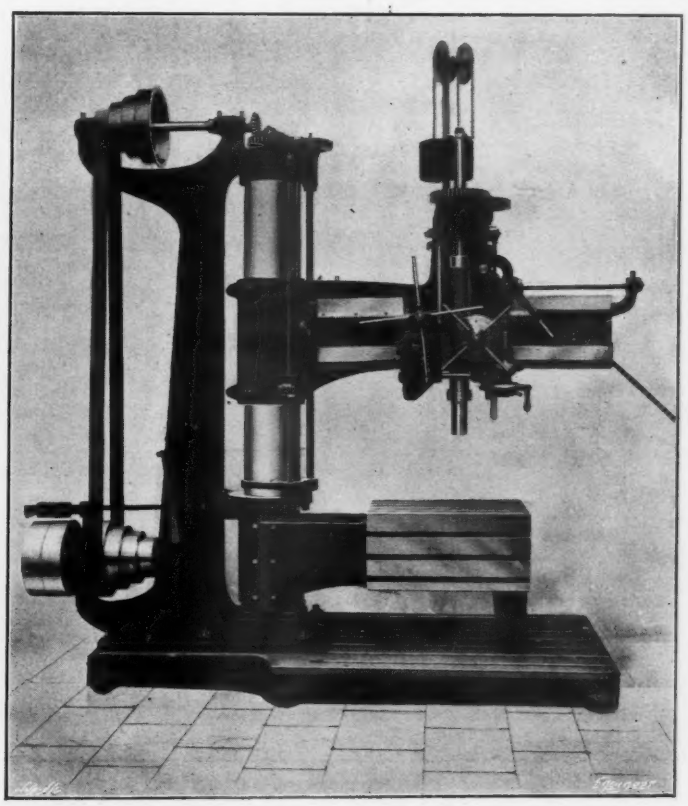


Fig. 14—6-FOOT RADIAL DRILL—J. ARCHDALE AND CO., LIMITED

A ratchet formed on the boss of the nutted pinion then prevents its rotation, and the screw runs back through its nut at the full rate of its pitch.

The machine illustrated deals with shell rings up to 10ft. in diameter, and the rate of drilling 1in. holes is 1½in. per minute. The vertical lever shown at the starting platform is linked to belt shifting

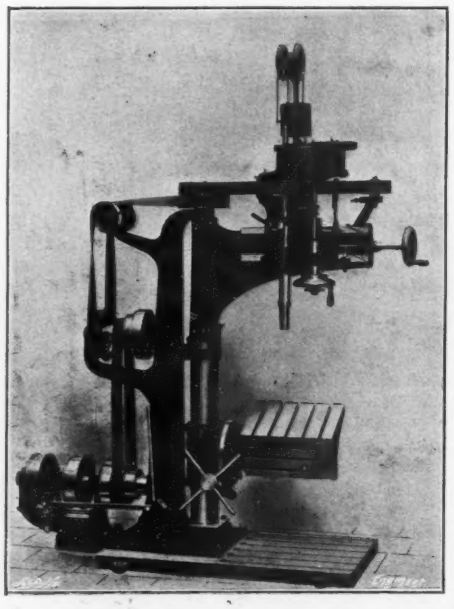


Fig. 16—SENSITIVE RADIAL DRILL—ARCHDALE & CO.

mechanism, which controls the go-ahead and reversing belts, but in some cases these have been superseded by an electric motor kept constantly running in one direction, reversal being accomplished by means of spur gearing put into operation by friction clutches.

The work of rotating the boiler for dividing is performed by a belt which normally runs slack till

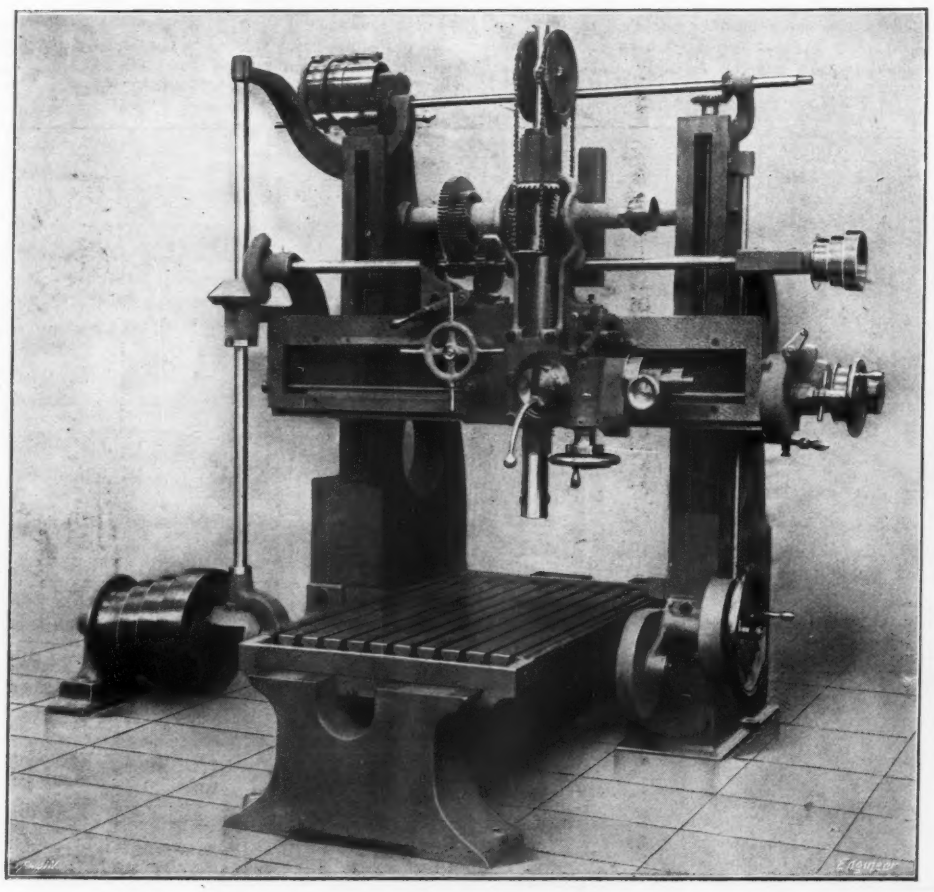


Fig. 17—PLANO DRILLING MACHINE—DARLING AND SELLERS

tightened by a jockey pulley put in operation by means of a foot lever, the correct number of turns of the worm being determined by a lever and catch plate geared to the worm shaft through change wheels. Independent adjustment is provided to each spindle for setting purposes to accommodate varying lengths of drills, and jets for suds are provided for keeping the drill points cool whilst working.

Messrs. Kendall and Gent, Limited, who are the original and sole makers of this machine since its inception by the late Mr. Dixon, have since that time made several modifications and improvements in the original design, and the machine illustrated represents the latest development of it for general boiler work.

A horizontal boring, milling, drilling, tapping, and studding machine, made also by Kendall and Gent, designed especially for heavy boring and milling work, is shown by Fig. 37, page xii. The bed and the upright are of box-section, and of substantial proportions. The saddle is counterbalanced and provided with quick hand and power adjustments in either direction, as well as variable self-acting feeds for milling both vertically and horizontally.

The spindle, of hard steel, has a quick hand adjustment by rack and pinion for rapidly advancing and withdrawing, as well as the usual hand and variable positive self-acting feed motions. Nine rates of feeds are available. It is also provided with stop and reversing motion by clutch and mitre gearing for tapping and studding. The spindle is carried in a cast iron sleeve running in gun-metal bearings, adjustable for wear. The drive is two ratios of single, double, and treble gearing, twenty-four speeds in all being available. All the adjustments for moving the upright along the bed, raising and lowering the saddle, adjusting the spindle by hand or power, as well as the self-acting feed motions, are operated by levers placed on the saddle, giving the workman standing on the platform entire control of all motions.

A base-plate 16in. deep, with planed T slots, is arranged to bolt to the side of bed, but is not shown in the engraving.

When supplied with a suitable self-acting boring bar and facing heads, this machine is capable of boring and facing cylinders up to 7ft. diameter. The diameter of spindle is 6in., the vertical adjustment of the saddle on the upright is 8ft., and the horizontal range 10ft.

The portable electrically-driven drilling and boring machine made by Kendall and Gent, and illustrated by Fig. 36, page xii., represents a type which is extensively used in large engineering works, shipyards, &c. It consists of a saddle carrying a boring bar mounted on an upright sliding on a planed bed of heavy section. The bar, which is 4in. diameter, is made of hard steel, and slides in a cast iron sleeve running in adjustable gun metal bearings. It is provided with hand and self-acting variable feed motion by a cut rack and pinion, five positive rates of feed being available, any one of which can be used without stopping the machine. The traversing mechanism of the bar is so arranged that after the full feed provided has been attained, the head may be run back quickly by rack and pinion, and a further traverse effected without withdrawing the bar. The driving is taken from a variable speed motor mounted at the top of

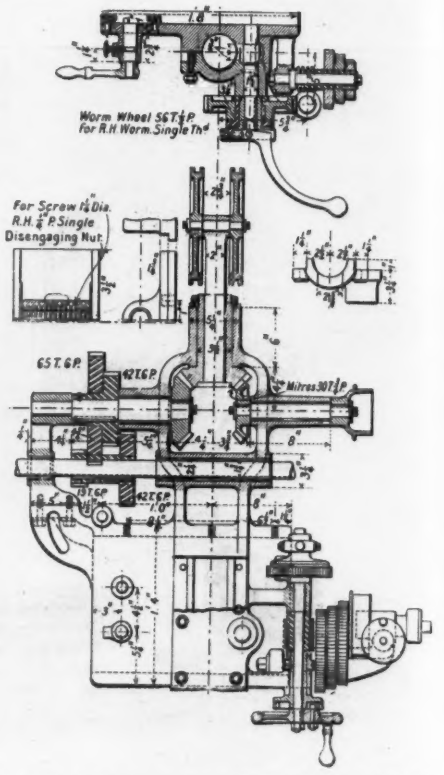


Fig. 18—PLANO-DRILL SADDLE—DARLING AND SELLERS

the column, and a range of speeds is attained suitable for drilling holes down to 1in., or boring them up to 36in. diameter. The feed provided for the boring bar is 2ft. 6in., and the highest and lowest positions from floor are 7ft. and 2ft. 6in. respectively. The length of bed usually provided allows of 4ft. 6in. traverse of the upright. The saddle is counterbalanced so as to be easily moved by hand; all wheels are cut, and where necessary made of forged steel. A lifting shackle at the upper end of the column provides a means for moving the machine about from place to place.

The three radial drills—Figs. 13, 14, 16—made by James Archdale and Co., of Birmingham, represent an interesting series. The fundamental type is, it will be seen, the same in all, but there are material differences in the three machines. The general type was introduced some ten years ago by the makers, but has been modified somewhat to suit new conditions. The principal feature is the method of staying the

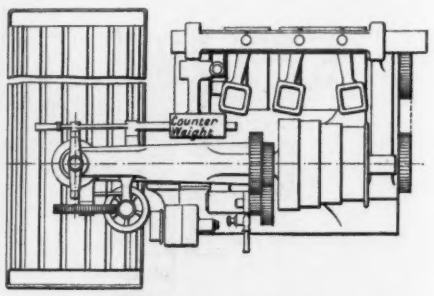


Fig. 19—PLAN OF DRIVE

vertical pillar carrying the radial arm by the cast upright at its back. This upright takes hold of the pillar at the top and at an intermediate point just below the radial arm. Furthermore, a large steel tension bolt passes from top to base inside the pillar, and helps materially to resist spring under the pressure of the drill. Five sizes of machines are made on these lines, with radius of arm 2ft. 3in., 2ft. 6in., 3ft. 6in., 5ft., and 6ft. The first size is represented by Fig. 16. The spindle of this machine being driven direct by a belt, it is a sensitive drill, but the belt is so arranged as to allow of both radial movement of the carriage along the slide and of the swing of the arm. It is thus a combined sensitive and radial drill, and, to meet the requirements of the former, it has a hand lever feed, which can be used for rapidly drilling small holes. But since it is powerful enough to drill holes up to 1½in. diameter, it is provided with self-acting and hand-wheel feed as well. A friction reversing gear is fitted to the countershaft

on the floor, and is actuated by the hand or by the foot. This is a convenient arrangement for tapping. The box table may be raised and lowered, swung out of the way to allow of big parts being bolted to the base, or swivelled for drilling oblique holes. The spindle runs in a sleeve, is balanced, and can be raised quickly by a lever. It has a ball thrust. Its diameter is 1¼in., its vertical movement 9in., and the travel of the saddle along the arm is 15in The driving belt is 2¼in. wide, and the driving pulleys make 250 revolutions per minute.

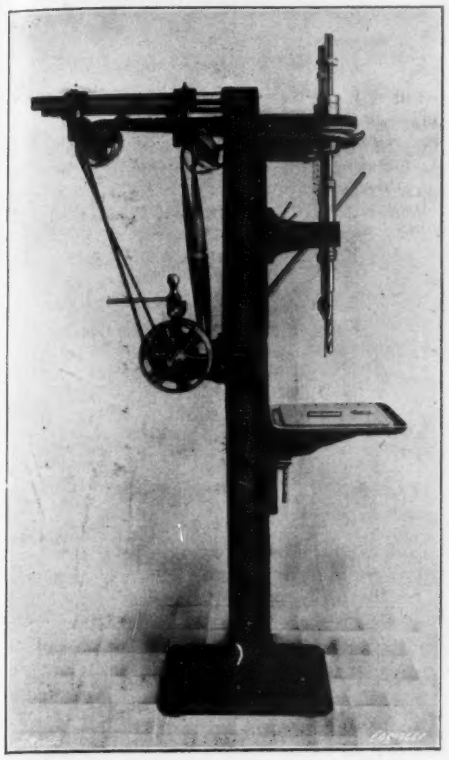


Fig. 20—SENSITIVE DRILL—SMITH AND COVENTRY

The next two machines of the series are represented by Fig. 13. They have radii of 2ft. 6in. and 3ft. 6in. The drive is from a constant speed belt

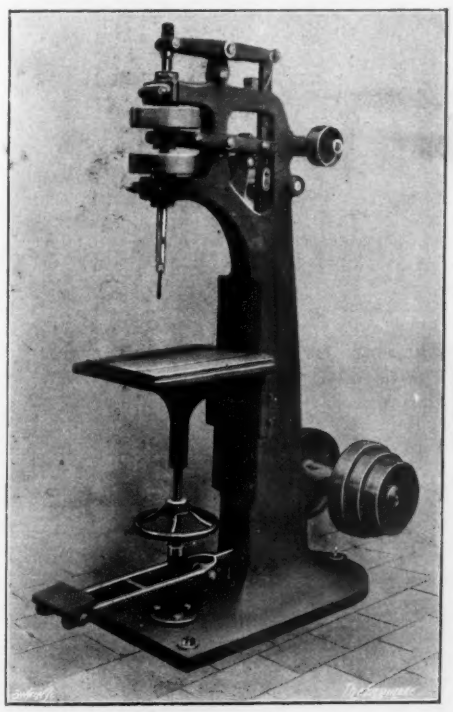


Fig. 21—DRILLING AND TAPPING MACHINE—CARRON CO.

or motor through the gear-box seen at the foot of the machine, and is taken up to the horizontal shaft by a Renold chain. The frame is substantially the same as that of the smaller drill, but the arm is supported on a roller bearing, and is of complete box section with the spindle brought up close to the face. The spindle is driven by a friction clutch in single gear for holes up to 1½in. diameter, and in double gear for larger holes. The introduction of a friction clutch permits of instant disengagement by the movement of a lever. The same lever actuates the double gear, so that the change from single to double may be made instantly with the spindle running. A friction clutch reverse is also provided. The feed is positive, and given four rates of progression, which can be varied with the machine in motion. The change speed box gives nine changes, or, including the double gear, eighteen changes in all. The saddle is guided on square edges on the arm, and is provided with rollers on the top edge to make it easier of adjustment. All the gearing is machine cut, and is, as the engraving shows, almost wholly boxed in. The spindle arrangements are much the same as in the smaller machine. Its diameter is 2½in., it has a vertical range of 12in., and a horizontal traverse of 29in. The table has a vertical adjustment of 8in. The following work has been done with this machine :—

Material.	Diameter of drill.	R.P.M.	Feed. in.	Depth per minute.
Mild steel	1	386	¼	8·21
,,	1¼	242	¼	5·15
,,	1½	242	⅛	3·02
,,	2	112	⅛	1·4
Cast iron	1¼	317	¼	6·9
,,	1½	275	¼	5·85
,,	2	112	¼	2·38

We now come to the two largest sizes, Fig. 14, and although there is a general resemblance in the design, there are a good many obvious points of difference. The drive is through a four-step cone instead of a speed box, and the gearing is spur instead of friction; the table has no rising motion, but the arm may be adjusted vertically by power on the long rotating sleeve enclosing the central column, and is clamped firmly in position. The sleeve is borne on a roller bearing, in order to facilitate the swing of the arm. The spindle is carried in one length, as in the other cases, through the upper and lower guides, and has a ball thrust. It has eight speeds, is graduated in sixteenths of an inch for measuring depths, and is bored No. 5 Morse taper. There are four gear feeds instantly changeable with the machine running. Double gear and a reverse are fitted on the saddle, the levers for both motions being conveniently placed for the operator. By putting the reversing lever in the central position the spindle is instantly stopped. The spindle of this machine is 2½in. diameter, and its vertical feed 15in. It may be moved 3ft. 4in. along the arm, and the arm may be raised 3ft. The speeds vary between 13 and 286, with 250 revs. of the driving pulley, and the feeds are 40, 73, 101, and 156 per inch.

Finally, we illustrate—Fig 15—a machine by Archdale and Co., designed especially for the use of high-speed drills. It is also a sensitive drill, the spindle being belt-driven and provided with a lever feed. Holes up to 1¼in. diameter are drilled by the belt drive direct, but for larger sizes a double gear is used. The belt pulley is coupled to the spindle by a friction clutch; the clutch lever also actuates the double gear, as in the 3ft. 6in. pattern. The spindle is similar to the others, is graduated in 32nds, and has a quick return motion. The power feed is positive, with three changes, and a hand worm-and-wheel feed is provided, as well as the lever feed already referred to. The spindle is 1⅝in. diameter, and holes up to 2in. diameter by 9in. deep may be drilled. The maximum spindle speed is 800, and the minimum 40, and the feeds are 78, 118, and 173

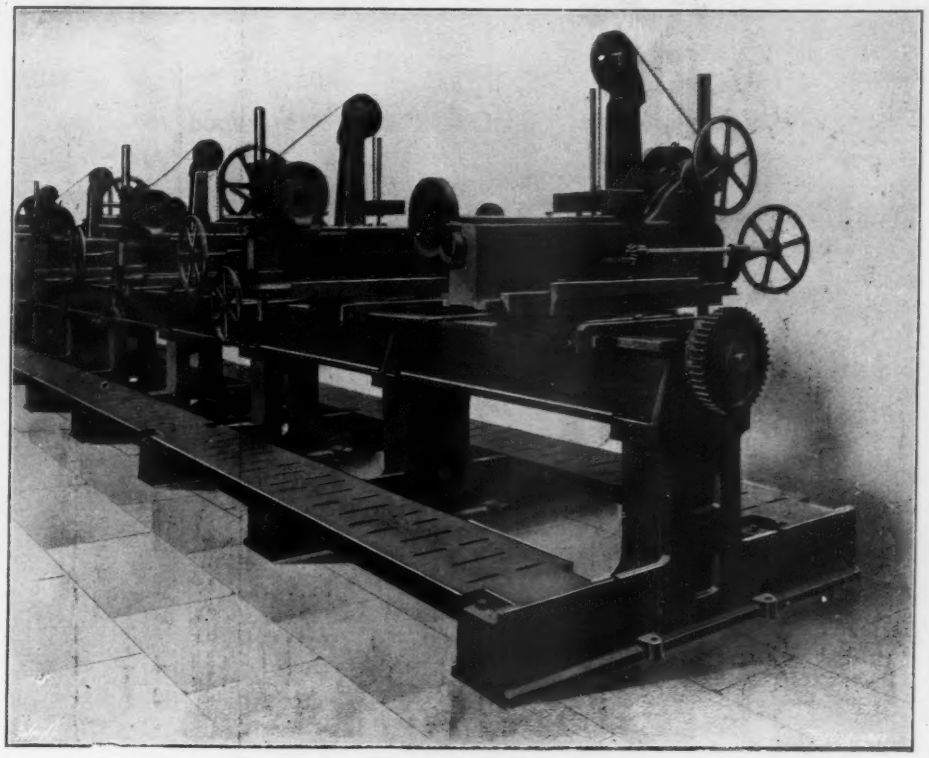


Fig. 22—GIRDER DRILLING MACHINE—J. BUTLER AND CO.

revolutions per inch. The driving pulley makes 400 turns per minute.

The high-speed vertical drilling machine made by Darling and Sellers, Limited, of Keighley, and shown in Fig. 24, page viii., is of the regular column type in its general framing. It is provided with a large

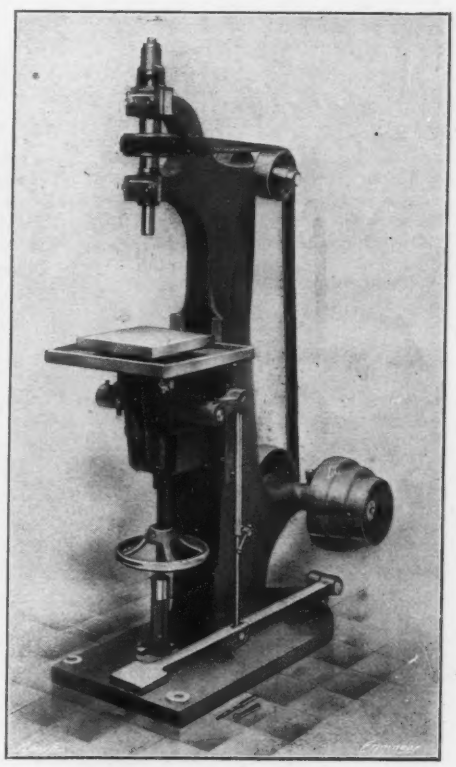


Fig. 23—SENSITIVE DRILL—CARRON CO.

rectangular work table bolted to an extension of the main casting, to ensure rigidity of support for the work under high-speed cutting. The size and type of table may, of course, be made to any desired design, the particular form illustrated having been made for a large firm of printing machine makers in the North.

VERTICAL DRILLING MACHINES

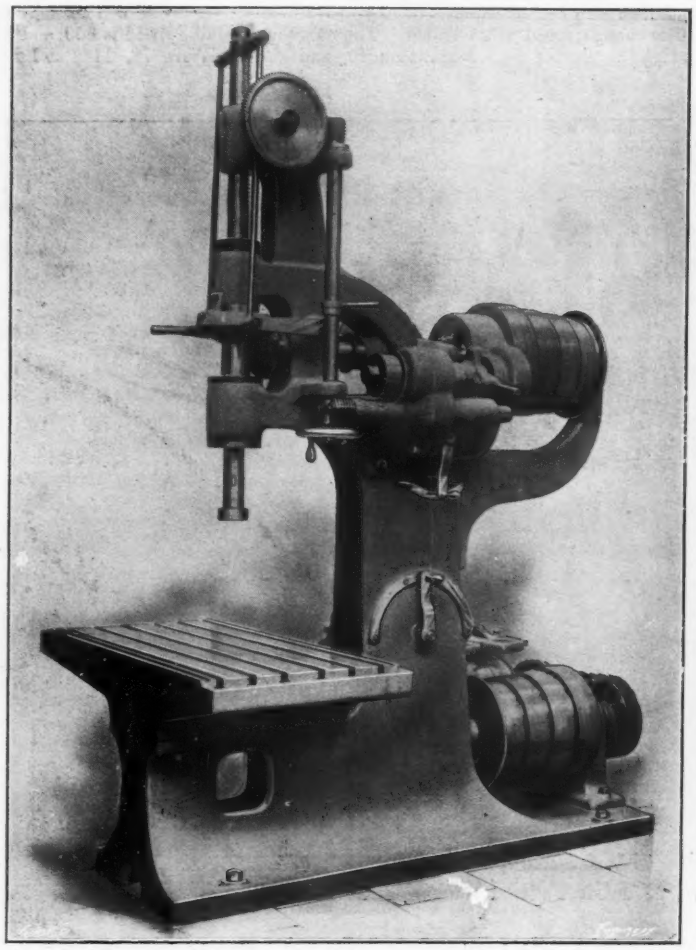


Fig. 24—MACHINE BY DARLING AND SELLERS, LIMITED

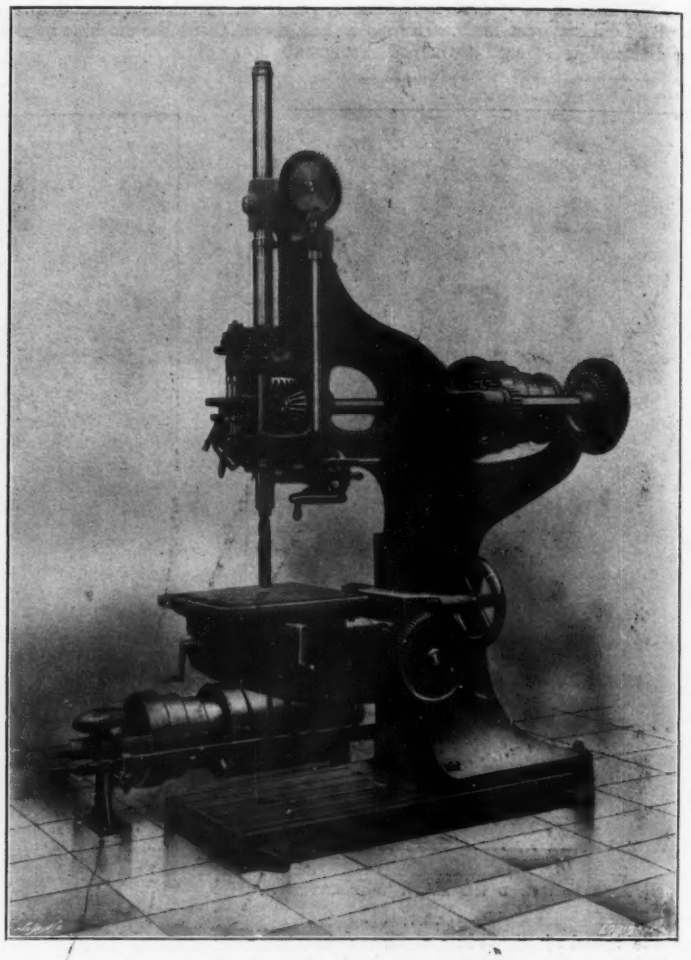


Fig. 25—MACHINE BY SMITH AND COVENTRY, LIMITED

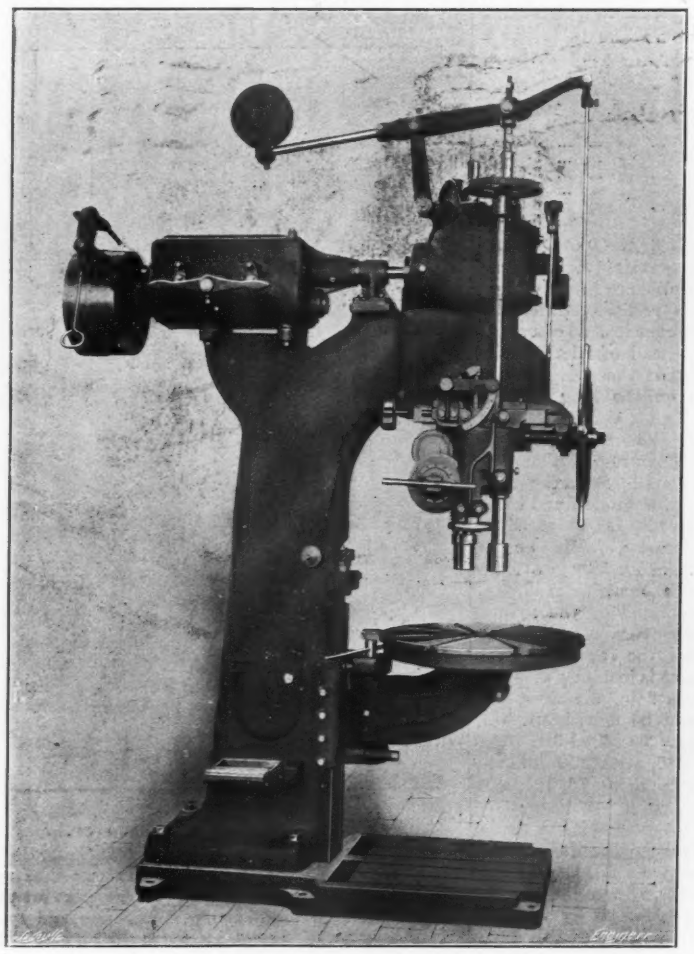


Fig. 26—MACHINE BY W. ASQUITH, LIMITED

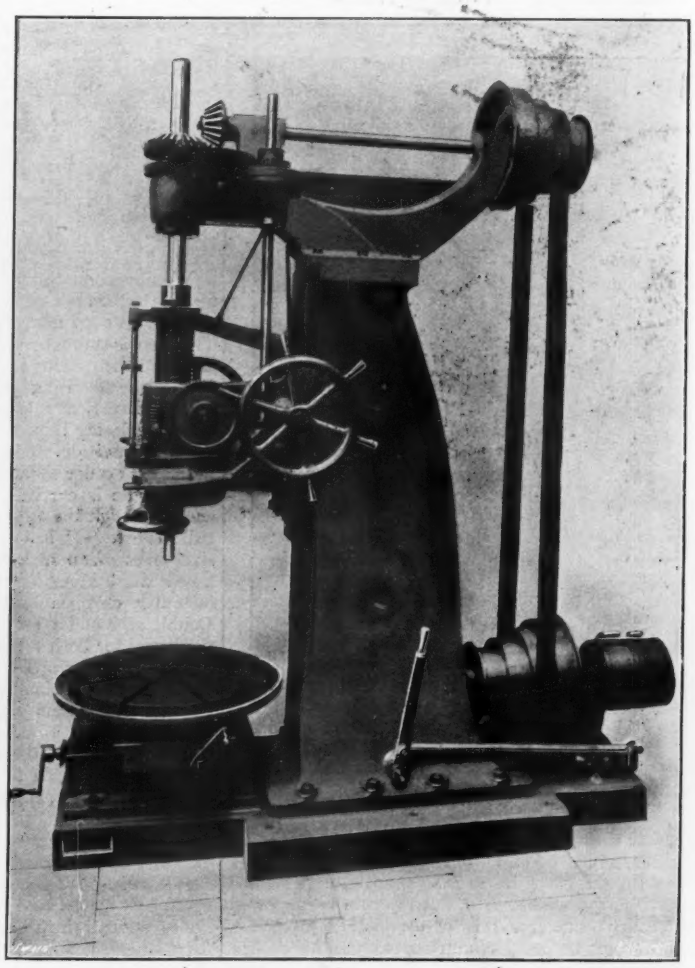


Fig. 27—MACHINE BY J. BUTLER AND CO

In addition to the usual features of balanced spindle, by a weight and rods, in this case, instantaneous disengagement of feed, quick return, completely encased gearing, &c., special attention has been paid to the drive and the feed, matters on which the experience gained by the makers in high-speed lathe work has stood them in good stead.

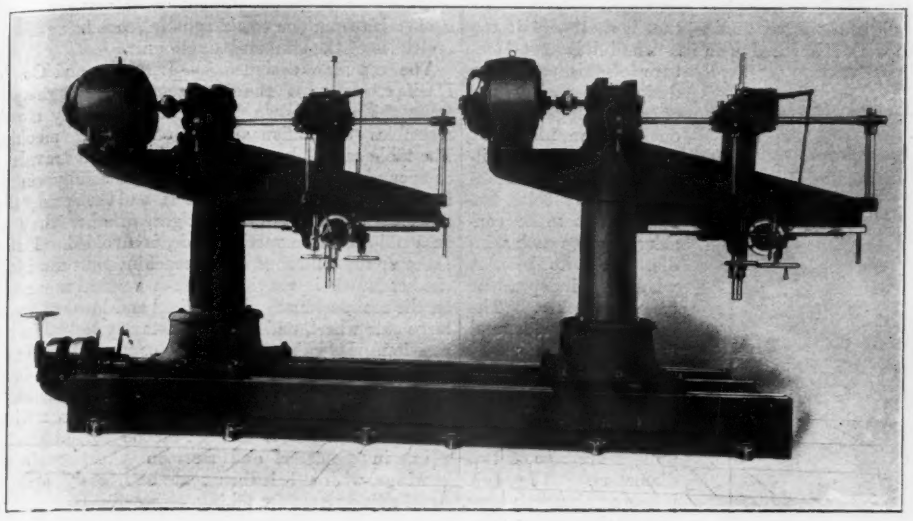


Fig. 28—DUPLEX RADIAL DRILL—W. ASQUITH, LIMITED

The drive is peculiar in having two countershafts placed side by side at close centres on the base of the machine, and connected with each other by a Renold's silent chain. The rear shaft, scarcely seen in the reproduction from a photograph, but clearly shown in the plan, Fig. 19, carries three pairs of fast and loose pulleys driven at different speeds from the line shaft above. By a triple arrangement of independently acting striking gear, any one of these speeds may be instantly engaged by a simple movement of the lower lever seen upon the standard. Three speeds are thus imparted to the second or cone countershaft, which in its turn gives four finely graduated speeds for each countershaft speed to the main driving shaft above. These are doubled again by the disengaging double gear mounted in front of the cone, thus giving twenty-four speeds in all, advancing by very slight gradations in unbroken geometrical progression from the slowest to the fastest. A glance at the speed cones shown in the illustrations will at once make clear the extent to which the present demand for small speed variation has been met. The back gear ratio is 2½ to 1, with a permanent reduction of 3 to 2 in the spindle bevel gears, and the cone steps are of 12¾in., 13½in., 14¼in., and 15in. diameter, with a capacity for 3½in. belt.

The feed rates are not so finely graded, but are instantly changed by the upper quadrant lever, and, in conjunction with the fine speed change referred to above, have been found to meet all requirements.

The steel spindle is 2½in. diameter, with the end bored to No. 4 Morse taper. A vertical feed of 12in. is provided; the maximum depth from table to spindle end, with the latter in its highest position, is 1ft. 9in., and from the centre of the spindle to the column 15½in. The net weight of the machine is 1 ton 19 cwt., and it occupies a floor space of 6ft. 2in. by 4ft. 6in. Needless to say, all gear wheels are machine cut from the solid. They are completely encased, as in all Darling and Sellers' machines. The large proportion of the spindle bearing may be seen in the engraving.

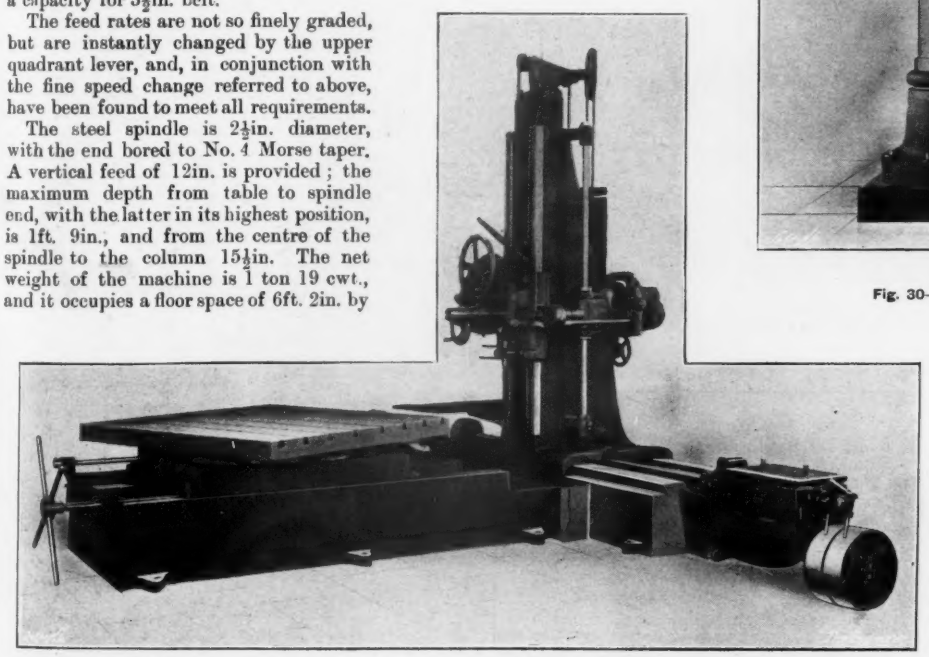


Fig. 29—HORIZONTAL DRILLING AND TAPPING MACHINE—W. ASQUITH, LIMITED

The following short table gives figures obtained in everyday use with this machine when using high-speed twist drills, and cutting cast iron out of the solid. If these speeds appear moderate, it must be remembered that they represent commercial everyday work, and are not intended either as maximum tests of the machine or the drill:—

Dia. of drill. in.	Cutting speed in ft. per min.	Feed in in. per min.	Cutting speed of reamer in ft. per min.	Feed of reamer in in. per min.
⅝	40	2½	26	1 5/16
⅞	45	1¾	30	1⅛
1 5/16	45	1½	30	1⅜
2	45	1 9/16	30	1 7/16

The speed for wrought iron is 10 per cent. faster, producing proportional increase in feed. Three-lip drills in cored holes are run at the same speeds, but one or two feeds faster, according to the strength of the drill and the amount of metal to be removed.

We illustrate in Fig. 17 a special vertical plano-drilling, boring and milling machine, made also by Darling and Sellers. In its general features of bed, table, standards and cross slide, this special tool follows the well-known planer type of milling machine; but it is essentially a drilling and boring machine, with provision for milling as an adjunct. It was designed in the first instance to operate on the assembled framework of small machines, but is well adapted for handling any general work within its capacity. A number of small and irregularly shaped seatings may be mounted on the table, and be milled either by longitudinal movement of the table or transverse movement of head on the cross slide—self-acting feeds in both directions being provided—and then any necessary holes may be drilled and reamed through them. Quick hand movements in every direction are available, and a simple arrangement of "bar" stops is provided.

The headstock, being shown in detail in a drawing, Fig. 18, calls for little explanation; but the position of the sliding gear change on the headstock itself may be noted, as well as the balanced spindle, disengaging feed, quick hand movement by spring clutch lever, and the convenient arrangement of the levers generally for operating the head.

A special feature of the machine is the friction-driven reaming feed, whereby the three regular feed rates may be instantly quadrupled in speed by engaging a friction clutch lever, thus permitting the reaming tool to be forced rapidly through its work, but not too powerfully to endanger the cutting edge in case of sudden obstruction.

The screw, which imparts transverse automatic feed to the headstock, is connected with a disengaging nut operated by a lever on the left-hand side of the head, the rapid hand motion by rack and pinion coming into play when the nut is released. Both this and the table feed are driven by encased mechanism placed for handiness at the cross slide end, and including reversing motion and accelerating gear for instant change from roughing to fast "dusting" cut for finishing.

The table is controlled by the hand-wheel seen on the front side of the machine, which engages through intermediate spur gears with a pair of fine pitch steel racks attached to the table.

This rack arrangement has been adopted instead of a screw feed, as giving the lightest and most rapid hand adjustment possible—a very important feature when bringing the various holes and seatings under the spindle. At the same time the efficiency of the rack as a steady medium for the milling feed has been safeguarded, not only by fineness of pitch already referred to, but by making both it and the pinion in two sections, placed side by side with staggered teeth, and arranging one of the racks with end adjustment to take up all lost wear.

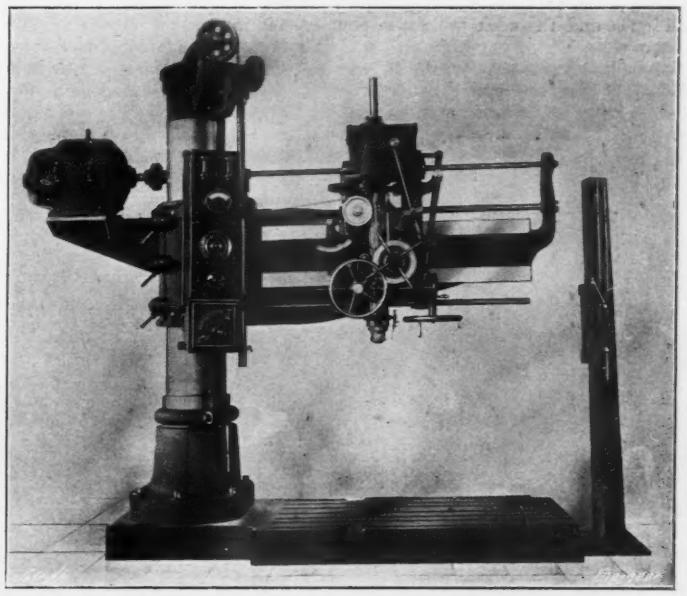


Fig. 30—7-FOOT RADIAL DRILL—W. ASQUITH, LIMITED

An effective drive has been provided for the cutter spindle, obtained from a four-step cone of large diameters through permanent bevel-geared reduction of 3 to 2, and sliding spur gears having a ratio of 3·4 to 1, giving, with two countershaft speeds, sixteen evenly graded speeds to the spindle. The vertical feed of the spindle has a range of 15in., and the feed rates are 80, 140, and 203 revolutions of spindle per inch, with acceleration for reaming to 20, 35, and 50 per inch. The milling feeds, both of the head along the cross-slide and the table along the bed, are 19·6, 27, and 37 revolutions of spindle per inch, with acceleration to 7·7, 10.7, and 14·8 per inch.

The maximum distance from spindle end to table is 3ft. 5in., and the width admitted 3ft. The table can be made any length, but is 4ft. 6in. long, exclusive of end wells, in the machine illustrated.

The extension in width of face of the rear standard, which will be noted immediately above the cone and

drive gear, has been left for the addition of an auxiliary horizontal spindle drilling or milling head at any future time, power for which can be easily taken off the existing vertical shaft.

A floor space of 10ft. 1in. by 10ft. 6in. is required for this tool, allowing for full table travel, and its finished net weight is just over five tons.

Quite apart from the fact that the machine can be used for milling without resetting the work, it is evident that the type of framing adopted admits of much greater stiffness than can be attained in radial machines, the cross slide being rigidly stayed at both ends, and the work table also equally solid in its support.

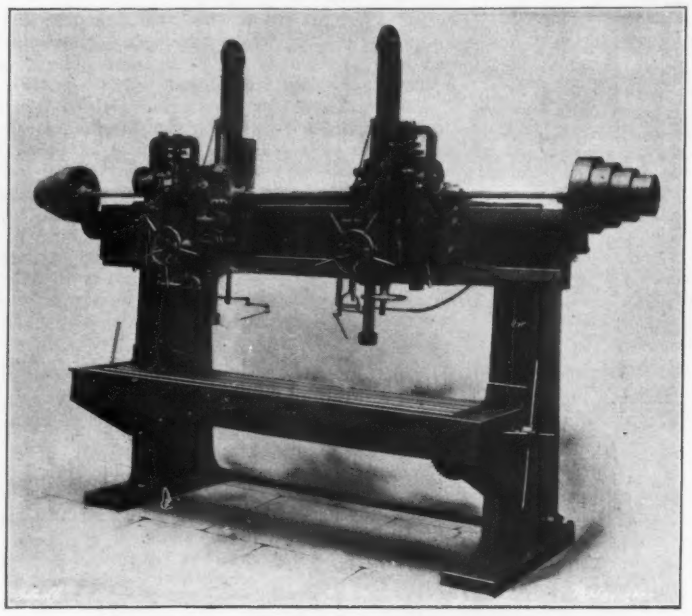


Fig. 31—TWO-SPINDLE DRILL—J. HETHERINGTON AND SONS

A drilling machine by Smith and Coventry, Limited, of Manchester, is shown by Fig. 25. It has a wide range of speeds, and may thus be used economically with ordinary or with high-speed drills. It is driven by a four-step cone of extra large diameter, and so stepped as to give with open, single, and double gear an evenly graduated rise in the speed of the spindle. The belt and the gear gives twelve changes, which, being doubled by a two-speed countershaft, provides twenty-four changes—more than enough to meet the most exacting requirements. Two sizes of machine are made. In one speeds from 22 to 535 revolutions per minute, and in the other from 15 to 325, can be obtained. The spindle is of steel, and is, of course, balanced. It has a ball-thrust bearing. It is driven by a set of bevel wheels with a clutch between them, so that the spindle may be instantly stopped and reversed for tapping. There are three feeds—25, 60, and 80—and a slow hand feed. The first three are taken from the spindle, and are instantly changeable. The table is mounted on a knee bracket, which may be swung to one side to give access to the tee-slotted base, to which big castings may be bolted. These two machines have spindles 2¼in. and 3in. diameter, and take drills up to 2¼in. and 3in. respectively.

A machine which is the very antithesis of this is shown in Fig. 20. It is the Rice sensitive drill—an American invention for which Smith and Coventry have taken the patent rights in this country. It is used only for small holes not exceeding ¾in., and has no gear wheels of any kind, since it is essential that it shall be sensitive, that is, that it shall slip if too much work is imposed upon it. The fundamental features of this particular design are the the use of ball bearings throughout and an idler belt drive. The machine illustrated has two spindles and two belts, but only one is to be considered, since each spindle, with its belt, is wholly independent from the other. The belt is 1¼in. wide, and is made continuous by cementing the ends together. On the driving shaft there is a two-step cone, and the spindle pulleys are also of two diameters. The belt passes continuously over the driving pulley, over one idler, round the spindle pulley, over a second idler, and back to the driver. The idler pulleys are supported from a circular horizontal bar. That nearest the spindle may be moved vertically, so as to lead the belt on to either the large or small diameter of the spindle pulley, whilst the further one may be moved horizontally, in order to impart the necessary tension to the belt. This arrangement allows of either spindle pulley being used with one and the same driver, and two speeds are thus obtained. But either of the driver steps may be used, the driving pulley being slid along its shaft to bring the desired step in line. Altogether, then, four speeds are obtained The locking of the idler pulleys is effected by knob screws; the driver has to be loosened and fastened with a special key. The changes are quickly effected. Friction is reduced to a minimum throughout by the use of ball bearings in all rotating parts. The spindle passes through a sleeve carried in ball bearings and taking all the belt pull, so that no side load falls on the spindle itself. Furthermore, the usual feather keys are replaced by rollers bearing against radial faces diametrically opposite, so that there is an equal turning moment on the spindle, and the frictional resistance to its rise and fall is considerably reduced. These machines are being made with from one to six spindles, each being simply multiples of the standard single unit.

The machine designed by J. Butler and Co., of Halifax, to meet the requirements of high-speed twist drills, is shown by Fig. 27. It very closely resembles a familiar design of milling machine. The table cannot be moved vertically, but travels on compound slides; thus it is carried solidly on the foundations of the machine itself, and the spring that accompanies all overhung designs, whether they are on a pillar or on a vertical slide, is avoided. But to make up for the range of the machine thus sacrificed, the headstock is provided with a vertical movement on the main column. It is raised and lowered by the large star wheel, and can be instantly locked in any position. Its balance weight is contained inside the casting. The spindle also is balanced, a lever being used as shown for convenience of design. The ample dimensions of the spindle sleeve may be noticed. The spindle itself is of high carbon forged steel, is 2¾in. in diameter, and runs in phosphor bronze bearings, with a ball thrust at both ends, and the usual adjustments for taking up wear. It is driven by a pair of strong machine-cut bevel wheels through a four-step belt cone, and has no other changes of speed. The largest step is 20in. diameter, the width is 3½in. The spindle speeds are 200, 300, 400, and 600. There is but one uniform positive feed for all sizes of drill, and thus all the complications of a change-speed box is obviated. The feed generally supplied is 100 revolutions of the spindle per inch travel, but a swing plate being provided, any change wheels may be easily fitted. The feed is brought down from the wheels at the summit of the machine by a vertical shaft to a pair of mitre wheels driving a horizontal worm, and which in its turn actuates a vertical worm wheel bearing the feed pinion. Both worms may be swung out of gear. The hand worm by an excentric, whilst the power worm is tripped by a stop motion, so that the feed may be arrested automatically at any predetermined point. A large hand-wheel on the far side of the machine provides for quick elevation of the spindle. This machine will drill ¾in. to 2¼in. holes; the spindle has a fall of 9in., and the maximum height under the spindle end is 2ft. 4in. The table is 30in. diameter. The driving pulleys are 12in. by 6in., and should make 495 revolutions per minute.

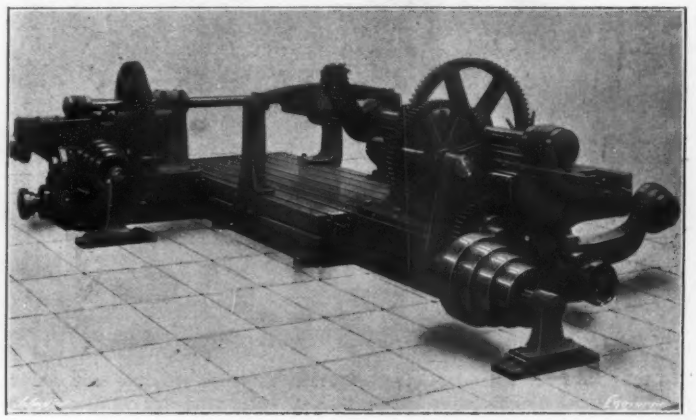


Fig. 32—SPECIAL BORING MACHINE—J. HETHERINGTON AND SONS

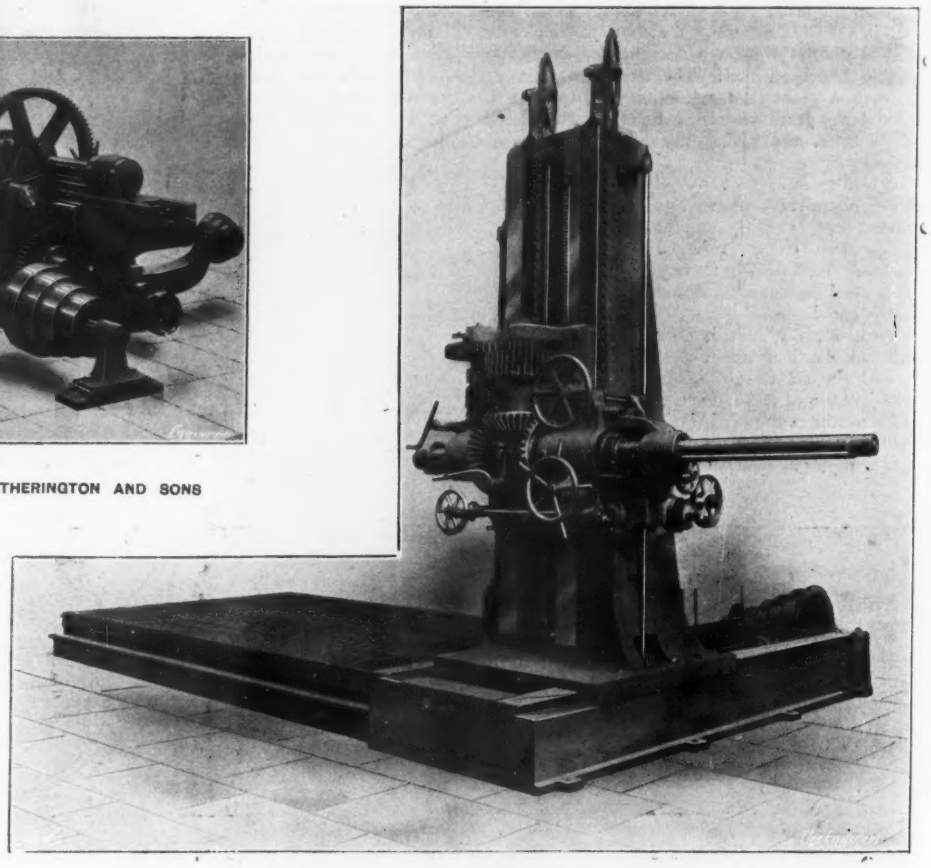


Fig. 33—HORIZONTAL DRILLING MACHINE—J. HETHERINGTON AND SONS

A drilling machine for girder work of all kinds is shown in Fig. 22. It was made also by J. Butler and Co. It consists of a long bed, carrying any

desired number of drilling heads, and provided with a table on each side on which the girder may be carried. The spindles are carried at the ends of rams which can be moved transversely to the bed or along it. Thus the two motions give the same adjustment as a radial arm, but have an advantage, in that in moving from one hole to the next in a straight line only one adjustment is necessary. Frequently only one table is provided, and the heads have then no swivelling motion, but in the machine shown they can be swung round so as to command either table. The drive is taken from a longitudinal shaft inside the bed, and rotated by a four-step cone at the far end. It provides also the means of traversing the heads by power, whilst large hand-wheels give the transverse and fine adjustments. The spindles are overbalanced, so that they withdraw themselves as soon as the drills are through the work.

The two machines by the Carron Company, of Carron, Stirlingshire, are of comparatively small size. The first, Fig. 21, will drill and tap holes up to $\frac{1}{2}$in. diameter in cast iron or brass, and $\frac{3}{4}$in. diameter in mild steel or wrought iron, at a high speed. The spindle passes through a sleeve, on which the two horizontal pulleys are mounted free, but to either of which it may be connected by a tooth clutch. The pulleys run in opposite direction, and so give the necessary reverse for tapping. The spindle is fed down by the foot lever, and at a predetermined point trips the reversing clutch, so that with either through or plug holes the tap withdraws itself at the desired depth. The belt passes up from the driving pulley below round an idler, which may just be seen through the frame, runs round the lower horizontal pulley back to the lower side of the front idler, over it and round the top horizontal pulley, and round another idler, which is invisible, back to the driver. By following out this arrangement it will be seen that the pulleys are caused to revolve in opposite directions.

The second machine, Fig. 27, is somewhat similar, but is without reversing motion, and the feed is secured by raising the table, or part of it, against the drill. The table as a whole may be raised by means of a screw on the column, whilst a secondary part of it is raised by foot power and a system of levers to effect the feed. The fixed part is provided with a tray to catch chips and lubricant. A stop motion provides for the drilling of holes of a definite depth.

Both these machines have steel spindles running in adjustable gun-metal bearings, and they are driven through three-step cone pulleys.

A very large and powerful radial drilling machine, made by William Asquith, Limited, Halifax, is shown by Fig. 30. The cut, unfortunately, does not give a very good idea of the size of the machine, but when we mention that the steady standard is 10ft high, a better appreciation of the size will be gained. The radius of spindle is 7ft. maximum and 2ft. 7in. minimum. The height admitted under the spindle when in the top position is 6ft. 3in. maxi- and 2ft. 10in. minimum.

The motor drive is arranged so as to eliminate as much gearing and shafting as possible, thus ensuring increased efficiency. The motor is, of course, variable speed, with a 3 to 1 variation at constant power. Double gear is fitted on the slide, and can be instantly thrown in or out, giving, with the speeds obtained by the shunt regulator, 120 drilling speeds, thus allowing the correct speed to be used for practically every size of hole and class of work. There is also a further range of speeds by series regulator, at less power, suitable for tapping and boring at normal speeds. The speeds range from a maximum of about 750 revolutions per minute down to about 65 revolutions per minute, with the addition of about twenty further slower speeds. The feeds—eight in number—are from 166 to 15 cuts per inch. It will thus be seen that the machine has an exceptionally good range.

In addition to the usual hand motions for adjustment along the arm, the slide is provided with a variable speed power traverse, enabling the spindle to be used for milling and facing large work in position after drilling. The spindle is $2\frac{1}{2}$in. diameter at the driving part, but larger in the sleeve in which it revolves, and which rigidly supports it when out at full traverse. The thrust is taken by heavy ball bearings. The spindle can be stopped, started, or reversed by lever under immediate control on the slide, for tapping and studding, changing drills, &c.

No little attention has been paid to the mechanical efficiency of the machine, shafts and revolving parts working in ball bearings where requisite. Only about $1\frac{1}{4}$ horse-power is absorbed by the machine when driving the spindle at top speed. The motor develops 10 horse-power. A few tests that have been made with the machine are recorded below. The material operated on was mild steel blocks, 5in. thick:—

$\frac{3}{4}$in.	hole was drilled at the rate of			$17\frac{1}{2}$in.	per minute.
1in.	,,	,,	,,	9in.	,,
$1\frac{1}{4}$in.	,,	,,	,,	$7\frac{1}{2}$in.	,,
$1\frac{1}{2}$in.	,,	,,	,,	$7\frac{1}{2}$in.	,,
$1\frac{1}{2}$in.	,,	,,	,,	6in.	,,

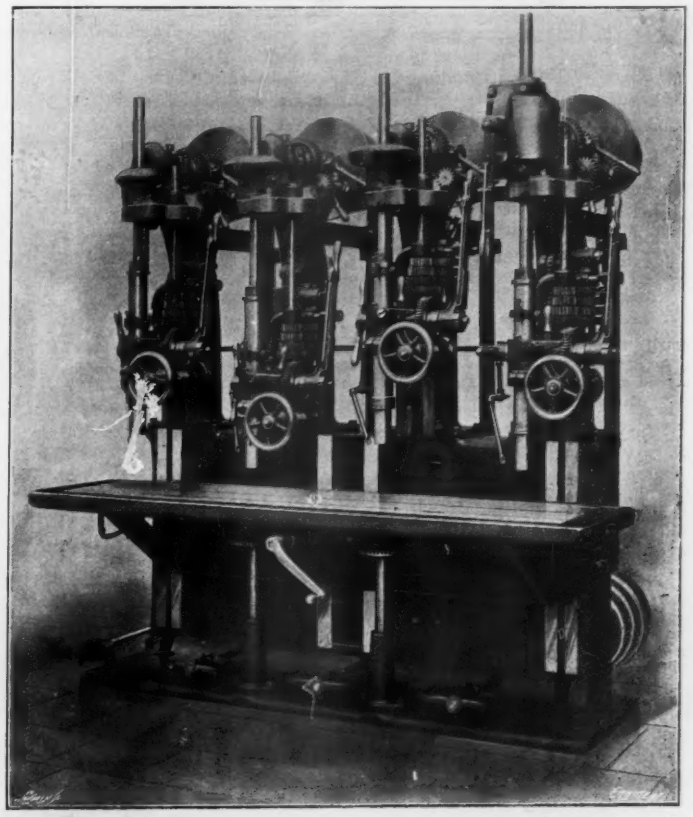
The horizontal drilling and tapping machine shown by Fig 29 was recently supplied by William Asquith, Limited, to a firm of marine engine builders for drilling holes in cylinder ends, tapping, facing, &c. It is intended for continuous high-speed service. The spindle is 3in. diameter, and has a traverse of 18in., with quick hand adjustment and automatic trip motion. The thrust is central, and is taken on ball bearings. Tapping is effected, and the spindle can be easily and quickly reversed, by means of a long lever immediately under the workman's control. This lever is counterbalanced, so that it may remain in any desired position, and the tap can be reversed at a much quicker speed by using a secondary lever.

The table is 5ft. square, and is provided with hand and power rotary motions for rapidly bringing work round to the desired position. The spindle is adjustable in height from a minimum of 6in. to a maximum of 5ft. from the top of the table, with a cross traverse of 5ft. The table has a traverse to and from the spindle of 3ft. by hand, and is indexed for drilling at any angle, with stops for every 90 deg.

The feed gear box gives eight changes of cutting speed, obtainable simply by moving levers whilst the machine is running, and the spindle has, with the double gear on the slide, sixteen changes of cutting speed, all accurately graded. There are eight changes of feed, also procured through gears by simply moving levers. The driving pulleys are of great diameter and width, running continuously at the same speed, and ensuring the constant great belt power necessary for using the new steels to advantage. The spindle speeds range from a maximum of 450 revolutions per minute to a minimum of 27 revolutions per minute.

The drill shown in Fig. 28 is an improved form of simple machine for taking full advantage of high-speed drilling on gun-carriage plates, girder framework, &c. The bed is 20ft. long by 5ft. wide. Along it are adjustable the two standards carrying arms, each half the length of the bed, by belt-power motion. The arms, supported on ball bearings, can be easily and quickly revolved on the standards, and securely locked. The makers' section of arm, which gives the advantage of central spindle thrust, is employed. The spindles are $2\frac{1}{2}$in. diameter, with 18in. vertical traverse, and are balanced. The thrust pressure is taken by ball bearings. An arrangement is provided whereby the feed motion is automatically knocked off when the drill is through the hole. The spindles can be stopped or started instantly from the slide. There are two changes of geared feed, either of which can be obtained instantly.

Each spindle is driven by a 10 horse-power variable-speed motor, with constant output at any speed between 900 and 300 revolutions per minute, giving very large range of speeds, obtainable simply by moving switches. The spindle speeds vary from about 450 revolutions per minute down to 50 revolutions per minute. The gear box at the pillar top doubles the number of speeds obtainable electrically. The motors, being mounted upon arms in the same style as in the 7ft. high-speed radial by the same makers, act partly as counterbalances, but, of course, the chief virtue of this method lies in the fact that it eliminates much shafting and gearing.



Figs. 34 and 35—FOUR-SPINDLE DRILLING MACHINE—WEBSTER AND BENNETT

THREE HORIZONTAL DRILLING MACHINES

KENDALL AND GENT, LIMITED MANCHESTER, ENGINEERS

(*For description see page* v.)

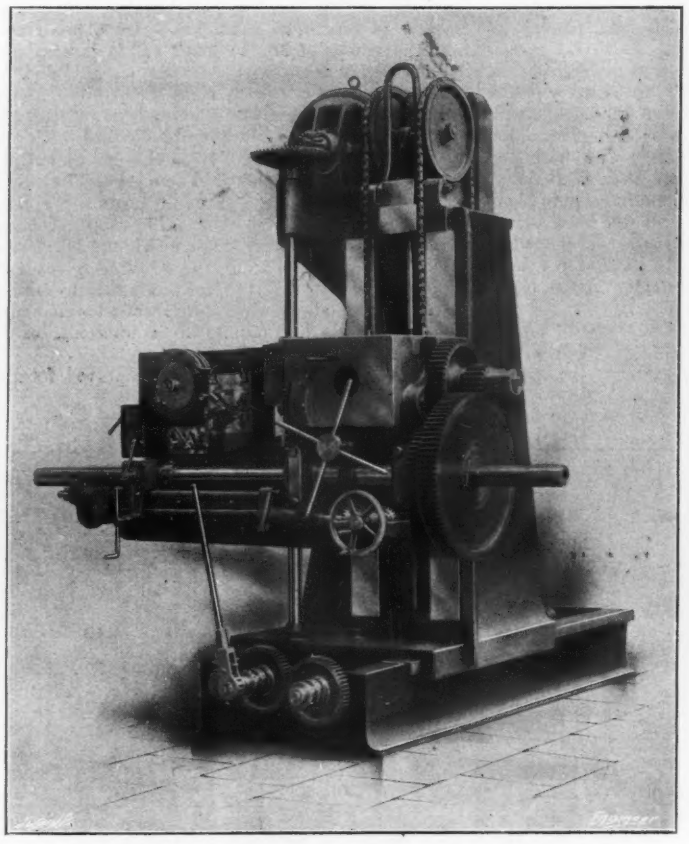


Fig. 36—PORTABLE DRILLING MACHINE

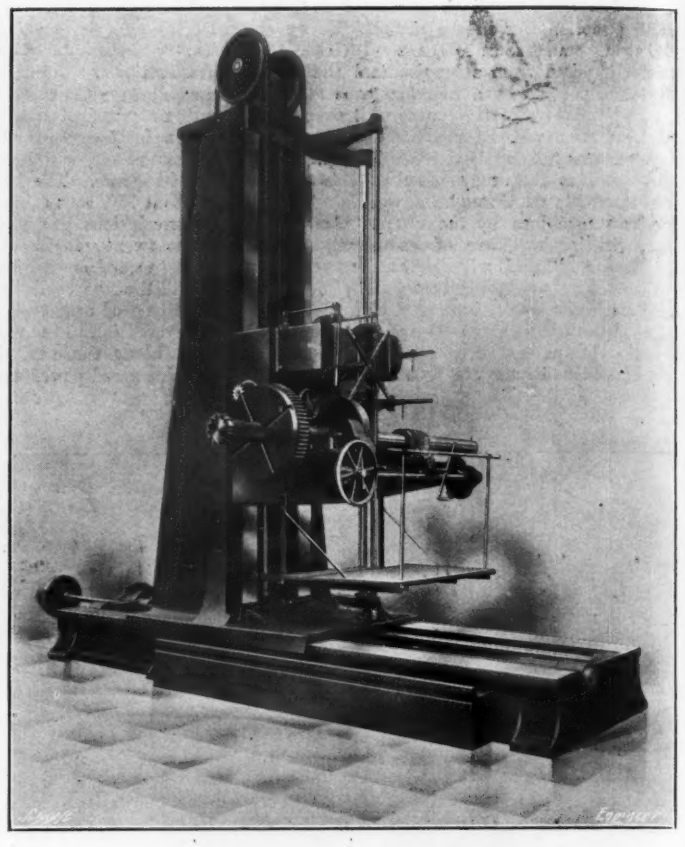


Fig. 37—HORIZONTAL DRILLING AND TAPPING MACHINE

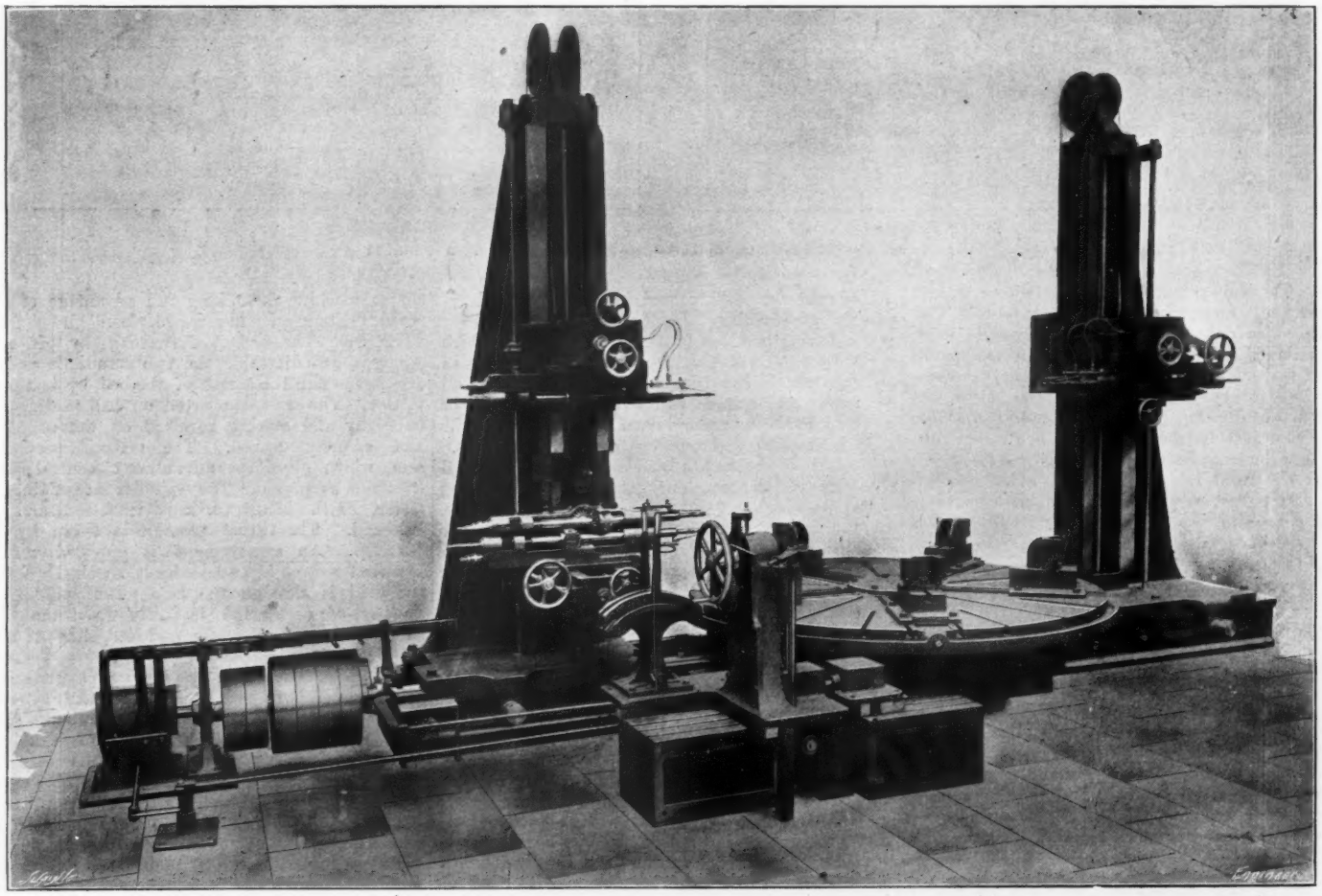


Fig. 38—BOILER SHELL DRILLING MACHINE

We illustrate also on page viii., Fig. 26, a two-spindle drilling and tapping machine by the same makers. The same principles which have guided the makers in the designs already discussed have been followed in this machine, and the reader will have no difficulty in picking out in the illustration the points of greatest interest.

An example of a two-spindle drilling and tapping machine made by John Hetherington and Sons, Limited, and intended for high-speed work, is illustrated by Fig. 31. The spindles in this case are driven by two separate four-step cones, through single and treble gear, and a set of mitre reversing gear. They are counterbalanced, but can be pulled quickly down to the work by a chain. They are of hard steel, and revolve in cast iron sleeves, which rotate in conical bearings, having lock nuts and friction washers for taking up wear. There are eight spindle speeds and three feeds, secured by a sliding key in the usual way. The table can be raised through worm and wheels and rack and pinion. This machine is made in four sizes, with spindles 2in., 2½in., 3in., and 4in. diameter, for 4½in. up to 5½in. belts. An horizontal drilling, boring, facing, tapping, studding, and milling machine, built also by John Hetherington and Sons, is shown in Fig. 33. It is fitted with a spindle very similar in its arrangements to that of the drilling machine just described. The drive is taken from a five-step cone by right-angle shafts to the double gear and mitre wheels on the sleeve. The machine is provided with all the motions necessary for the long list of operations mentioned in its full title, and it is not necessary to describe them in detail. The ample proportions of the driving wheels may be noted.

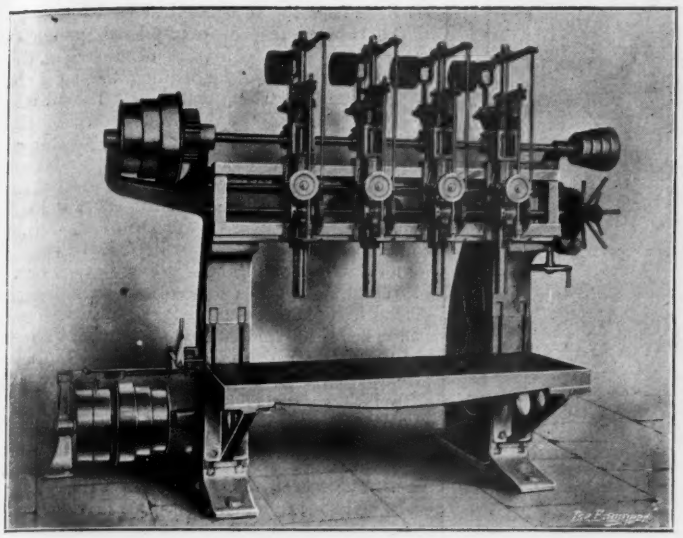


Fig. 39—MULTIPLE DRILL—LOWMOOR CO., LIMITED

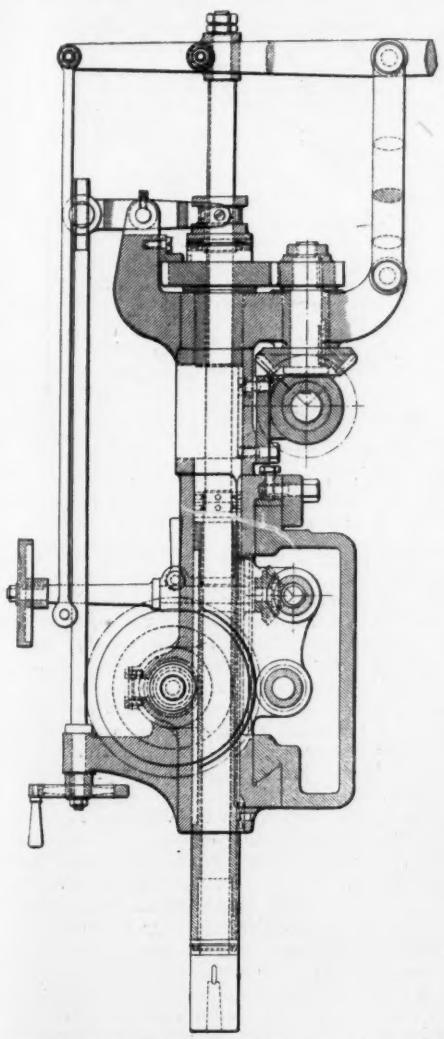


Fig. 40—DRILL SPINDLE—LOWMOOR CO., LIMITED

Finally, we illustrate, Fig. 32, a special horizontal boring machine made by John Hetherington, which represents a class of tools much used by gas and oil engine builders. Its function is to bore and face the cylinder and the crank shaft bearings at one setting. There are two heads, fixed rigidly at right angles to each other, and provided with suitable boring bars for the objects intended. Once bolted to the solid table, it is impossible for the work to get out of truth. Besides gaining this very essential point, the fact that two operations are done at once realises an economy of time. The cylinder boring bar is of hard steel sliding in a long cast iron sleeve, which revolves in adjustable paraliel bearings. The back bearing is so arranged that the bar may be quickly removed, or that its relative longitudinal position may be varied. The drive is taken from a four-step cone through treble gearing on the bar sleeve, and six changes of speed are obtained by the use of a pair of two-step and three-step cones. There is also fitted a power traverse for the bar for running it in and out. The boring bar for bearings has similar driving gear, but has not the quick power adjustment. The larger bar is 6in. diameter, and the smaller 4in. The height of centres from face of base plate is 2ft. 2in. The machine will bore up 2ft. 8in. diameter by 1ft. 11in. long. The feeds are between $\frac{1}{16}$in. and $\frac{3}{8}$in.

The four-spindle drill by Webster and Bennett, of Coventry, illustrated by back and front views, Figs. 34 and 35, is interesting from the fact that it is a true gang drill, each spindle being entirely independent in every sense, including the drive from its fellows. It represents a type which has been proved useful and profitable for successive operation work. For example, small parts may be successively drilled, reamered, countersunk, and tapped by having a suitable tool mounted in each of the spindles. The countershaft, with fast and loose pulleys, lies near the ground, parallel to the machine, and drives transverse four-step cones, which are belted to the driving gear above. The belt-shifting gear is operated by a treadle, brought to a convenient position in front; the operator's hands are thus left free. A double gear is fitted to each spindle, and may be thrown in and out at will. The lower spindle bearings are adjustable vertically upon the uprights by rack and pinions, and are balanced. The spindles themselves are balanced independently. They run in long steel sleeves bushed with gun-metal, the end thrust being taken on friction collars with adjustable lock nuts. The automatic feed is positive and variable. The change gear is of the sliding spring key pattern. There is also a hand-lever feed for light work. The automatic feed is put in by a short vertical lever, held up by a trigger. When a movable striker on the sleeve presses down the trigger, the lever is released and the feed stopped instantly. One of the end spindles is provided with reversing motion for tapping. All the gears are cut from solid blanks. The smallest diameter of the spindles is 1½in.; the automatic feed is 10in. There are eight speeds and four rates of feed, and their range is shown by the following chart for a drilling, counterboring, reaming and facing, and tapping job on the four spindles:—

Four-spindle 1¼in. Gang Drill.

One spindle.		Two spindle.		Three spindle.		Four spindle.	
Drilling ⅝in. to ¾in.		Drilling ¾in. to 1in.		Reamering and facing.		Tapping.	
Countershaft, 480 revs. per min.		Countershaft, 480 revs. per min		Countershaft, 360 revs. per min.		Countershaft, 480 revs. per min.	
Spindle speeds. Gear out.	Gear in.	Spindle speeds. Gear out.	Gear in.	Spindle speeds. Gear out.	Gear in.	Spindle speeds. Gear out.	Gear in.
608	304	406·6	203·3	300	80	406·6	203·3
505·7	252·8	338	169	225	50	338	169
421·2	210·6	281·6	140·8	144	32	281·6	140·8
350	175	234	117	90	20	234	117
Cuts per inch.		Cuts per inch.		Cuts per inch.		Cuts per inch.	
120		120		84		120	
104		104		27		104	
80		80		18		80	
54·54		54·54		9·5		54·54	

As representing a high standard of a typical design of horizontal boring machines we have selected one of H. W. Ward and Co.'s latest patterns, Fig. 42. It includes all the arrangements which are looked upon as necessary in high-class modern practice, and is, therefore, typical of the highest standard in this class of machines. The headstock is cast in one piece with the box on which the knee bracket slides, and practically all the gear is enclosed within the casting. The boring bar runs through a long sleeve carrying the driving cone, and this sleeve revolves in gun-metal bearings, split and capped to allow of adjustments. The driving cone has four steps 2¾in. wide, and a

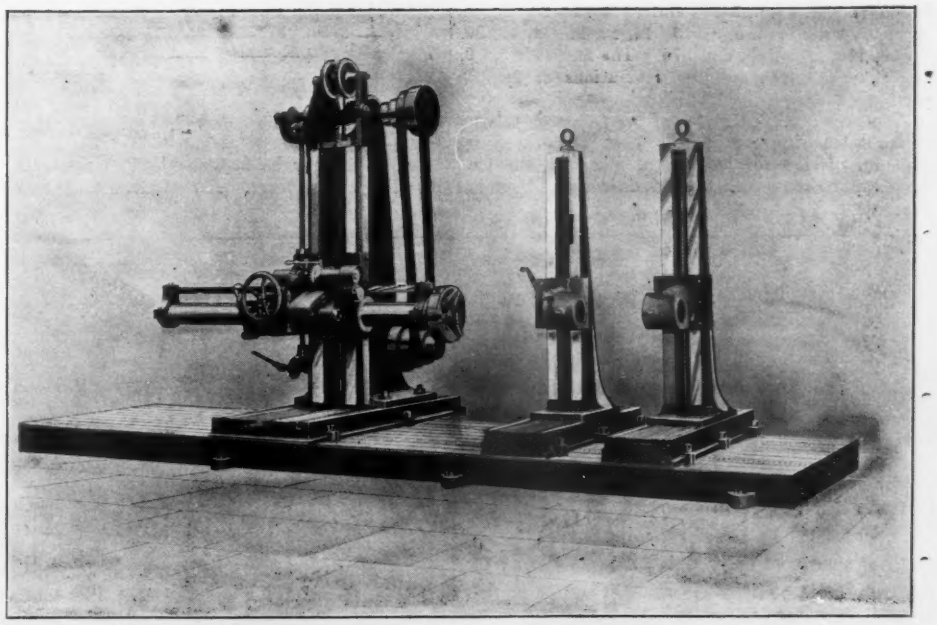


Fig. 41—HORIZONTAL BORING MACHINE—J. STIRK AND SONS

7 to 1 back gear, giving in all eight changes, which are doubled by a two-speed countershaft. The boring bar is 2½in. diameter; it is made of hard steel, and has two keyways cut its entire length. It is driven by keys 5½in. long.

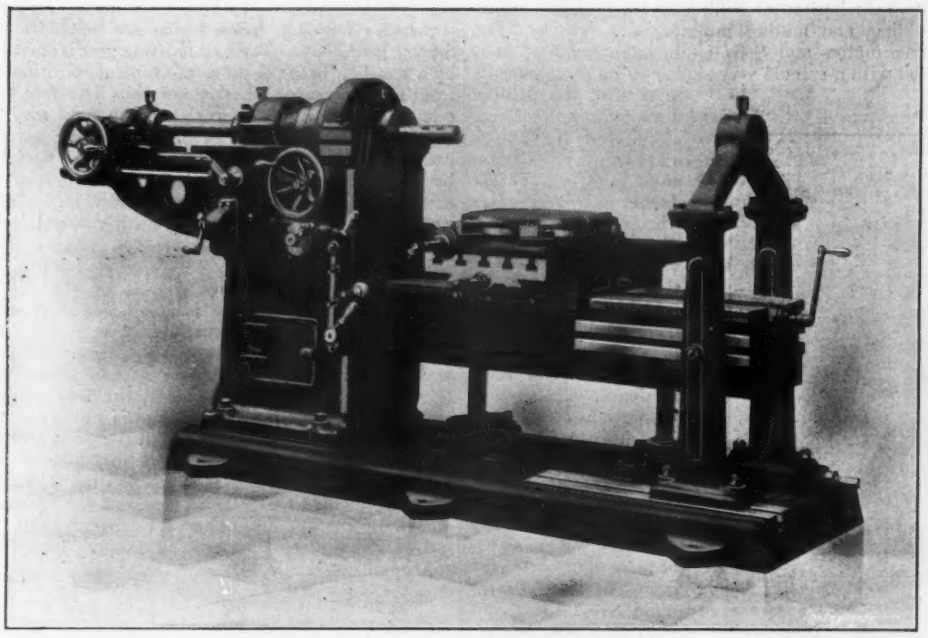


Fig. 42—HORIZONTAL BORING MACHINE—H. W. WARD AND CO.

The feed is taken from gearing at the tail end of the spindle inside the headstock, and passes through a change-feed box, giving eight variations and a reverse. The feed shaft is splined, and carries a worm driving a worm-wheel, to whose spindle is clutched a pinion which meshes with a rack in the square edge tail slide; thus the bar, firmly gripped by the feed bracket, is fed forward. Since the bar must be able to rotate, it passes through a hardened steel bush free to rotate in the feed bracket, to which it is made fast by gib keys.

The table has a compound motion, and a supplementary table, with revolving mechanism, may be mounted on it. The knee bracket is raised as a whole by a ratchet lever at the end of the bed revolving the nuts for the screws, or by power taken by an open and crossed belt direct from the countershaft.

The end steady may be moved a distance ef 30in. along the bed, so that it may be brought as close to its work as possible. A few of the principal figures for the machine are:—Floor space, 12ft. by 5ft. 6in.; diameter of spindle, 2½in.; traverse at one setting, 18in.; maximum height of spindle above table, 24in.; knee bracket, 5ft. long by 16in. wide. The driving cones are 6in., 7¾in., 9½in., and 11½in. by 2¾in. face. The speeds are 5, 7, 8, 9, 13, 14, 20, 22, 32, 42, 50, 65, 98, 150, 162, 245, and 375. The feeds are 5, 10, 20, 30, 40, 60, 120, and 240 revolutions of spindle per 1in. of feed.

Another good example of a standard pattern horizontal boring machine is that illustrated by Fig. 43. It is made by George Richards and Co., Limited, of Broadheath, near Manchester. A section through the headstock appears in Fig. 44. The step cone has four diameters and driving through two sets of back gears it gives twelve speeds to the spindle, doubled by a two-speed countershaft and following each other by regular steps. There are six changes of feed, and the spindle can be advanced by hand by a wheel on each side of the headstock. The spindle is fed forward in the usual way by a sliding bracket, to which it may be fastened in two positions, thus doubling the traverse. A compound table is shown fitted to the machine; it is provided with an automatic cross traverse for milling, and is raised or lowered by power or hand. The machine is made in three sizes with spindles of 2in., 2½in., and 4in. diameter, having respective traverses of 18in., 24in., and 36in. The largest machine weighs something like seven tons.

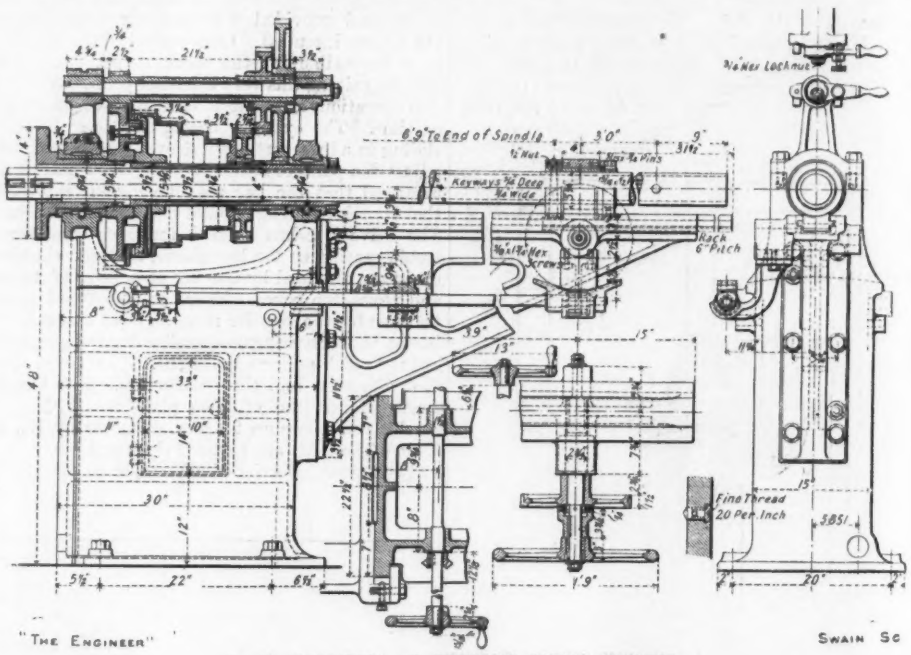


Fig. 44—HEADSTOCK OF RICHARDS' BORING MACHINE

Whilst Messrs. G. Wilkinson and Sons, of Keighley, make a number of drilling and boring machines of standard patterns, they have also from time to time been called upon to design and construct machines for special purposes, and we have in preference to illustrating examples of their machines which differ but little from the recognised designs selected three which, because they are exceptional, present more features of interest. The first of these, Fig. 47, is a nine spindle drill used for drilling the holes in the beater bars of thrashing machines. These bars have to be turned out by the thousand all precisely similar, and the possible adjustments on the machines are, therefore, reduced to a minimum. The heads are movable along the cross-slide, but they are attached to it by bolts and keep-plates, and once set are likely to remain in the same position for many months. The spindles are never used separately, and hence there are no clutches for throwing one or another out. As all the drills work together, and only together, a general feed for the whole number meets the requirements, hence the feed is effected by raising the table, and there is no vertical movement of the spindles except that the sleeve of any spindle may be lowered a few inches and clamped in position to accommodate any length of drill. The method of driving the spindles is worth observing, a screw or worm and helical pinions being used in place of spur or bevel gear. The worm, 3½in. diameter, 2½in. pitch, four leads, and runs in an oil bath. Its driving pulley is 18in. Each spindle is 1in. in diameter, makes 400 revolutions per minute, and drills ⅝in. holes. The rising table is 6ft. long by 12in. wide, including the channel. It has a variable self-acting feed, clutched in by the lever seen to the left of the machine, and also a quick rising and falling motion operated by crossed and open belts controlled by the central lever. This is employed for bringing the work up quickly to the drills. The longitudinal table to which the work is bolted is 5ft. 6in. long by 8in. wide, and has suitable dividing arrangements at the end for moving it endways the correct amount for different pitches. Lubricant is pumped from a cistern below the tables to each spindle. The whole operation from one set of nine holes to another occupies about 75 seconds.

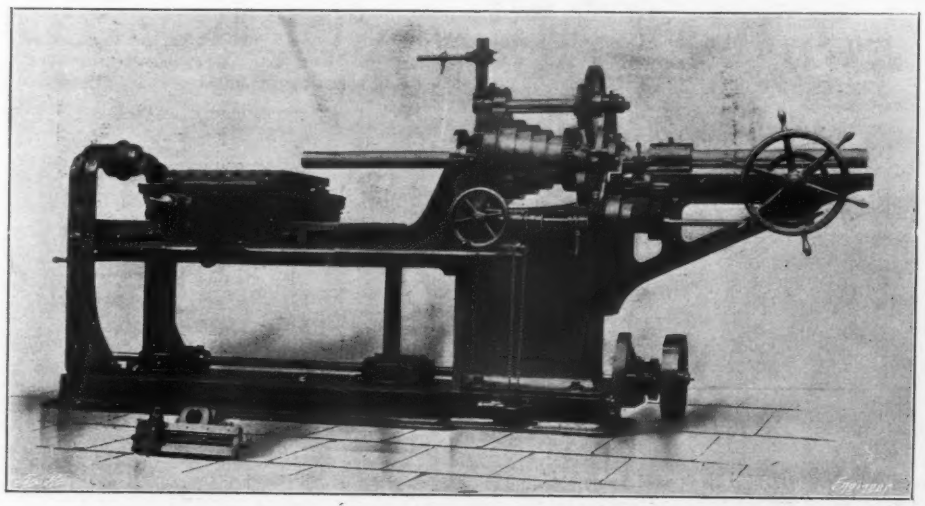


Fig. 43—HORIZONTAL BORING MACHINE—G. RICHARDS AND CO., LIMITED

The second machine by G. Wilkinson and Sons—Fig. 46—has been specially designed and constructed for drilling three holes simultaneously in the rims of steel wheels. The three drilling heads are mounted on the three arms of the base-plate and are adjustable radially along the slides. A large belt cone drives a central bevel wheel, which in turn drives the three radial shafts, to which are splined pinions driving the spur wheel on the drilling heads. The feed is taken from a worm on the spindle through mitre wheels and spur gear to a feed screw; on the worm being released feed may be effected by hand. The spindles are 2¾in. diameter, and the feed is 15in. The heads have a radial movement of 12in. The diameters of the driving cone are 22in., 18in., 14in., and 10in., and the width is 5in. The spur and pinions driving the spindles have respectively 60 and 20 teeth, and the pitch is ⅞in. The machine weighs about 3¼ tons.

A fine example of a special type of boring machine, made by the same firm, is illustrated by Fig. 45. It has

been specially designed for boring the seats of large valves, and facing the flanges; but it is suitable for general boring work as well. The machine has both boring bar and face plates, but they are driven independently of each other, and may be run at different speeds. The right-hand head is similar to the left as respects the face plate and its gear, but is without the arrangements for driving the boring bar, which however, it supports.

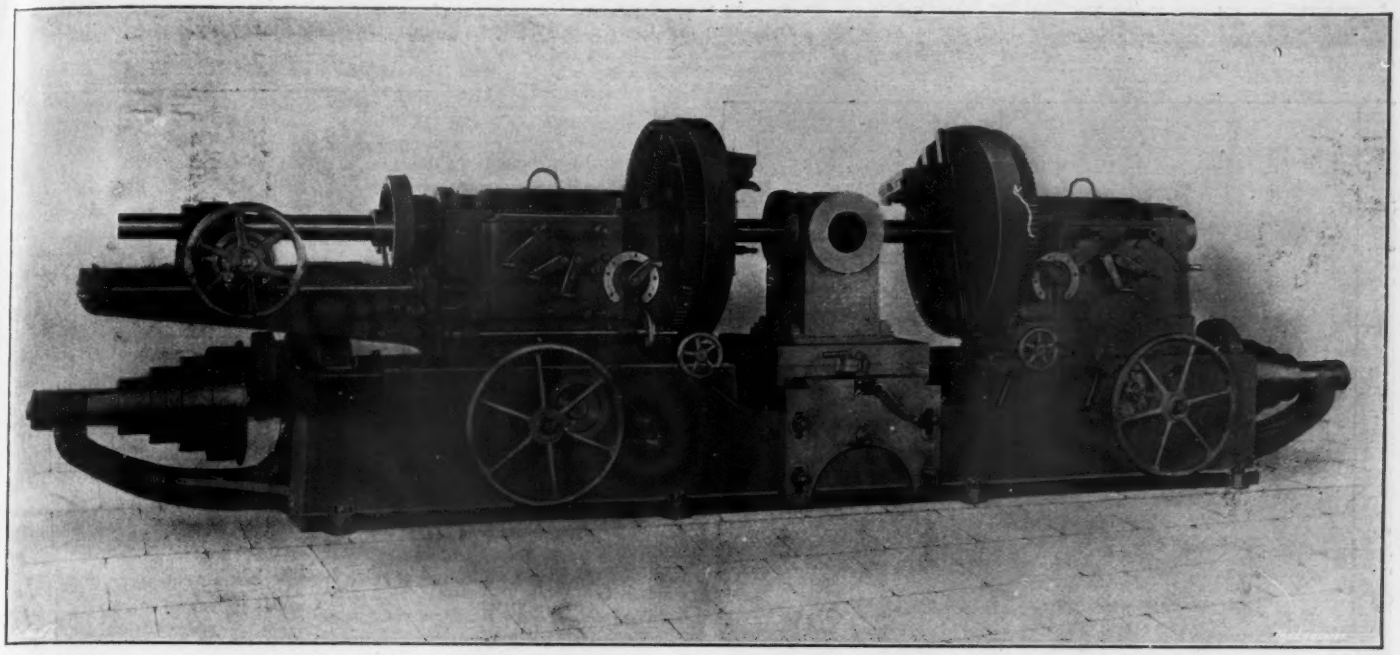


Fig. 45—VALVE BORING AND FACING MACHINE—G. WILKINSON AND SONS

A fuller description of the machine will be found in our issuo of August 4th last.

The subject of Fig. 48 is a very specialised type of machine. It is designed for drilling holes in groups, and particularly in the flanges of pipes, valves, cylinders, &c., where the arrangement is circular, but any combination of the spindles within their limits is possible. The feature of special interest is, of course, the drilling head. This carries six radial slides, each slide having a drilling spindle which can be moved to or from the centre. Each spindle is driven by universal joints, and a telescopic shaft from a central pinion. The telescopic shaft allows of independent adjustment, for length of drill, but once set, all the drills begin and end the operation together. The whole saddle with its spindles and drills is balanced, and may be moved vertically by hand or power for adjustment, but is not used for the feed. This is obtained by rotating a long nut on a screw below the table, and so raising the knee bracket.

Three speeds of rotation of the nut, and hence rates of feed may be given and may be changed instantly with the machine at work. The table can be rotated, and is provided with dividing gear, so that intermediate holes may be drilled. The circular table may be removed, leaving a large hole through which pipes may be passed into a suitable hole in the ground, or the table may be swung sideways out of the way if desired. In this machine there are six spindles, but machines with more or fewer spindles are built. Six holes up to 1in. diameter may be drilled simultaneously; the vertical feed is 6in. long, and the independent adjustment of each spindle 3in. The smallest circle on which all six spindles may be used is 7¼in., but if only four are in use a 5¼in. circle can be drilled. The largest circle is 16in. for any number of drills. This machine is made by the Low Moor Co., Limited, of Bradford.

An ordinary multiple drill by the same makers is illustrated by Fig. 39, page xiii., and a section through one drill head appears in Fig. 40. It is provided with four such heads, which can be adjusted independently along the cross slide by means of a pair of mitre wheels on each head, one of the wheels being chased to fit on a screw carried inside the cross slide. This screw is held stationary whilst the adjustment is being made by revolving the disc wheels seen in front of each head. The minimum centres between two drills is 8in. The intermediate holes, between those drilled by the heads when fixed in position, can be drilled by moving all the heads along the cross slide simultaneously, this being done from the end of the cross slide by means of a horizontal hand-wheel through a quick thread worm and worm wheel, the latter being keyed on the end of the screw carried on the cross slide.

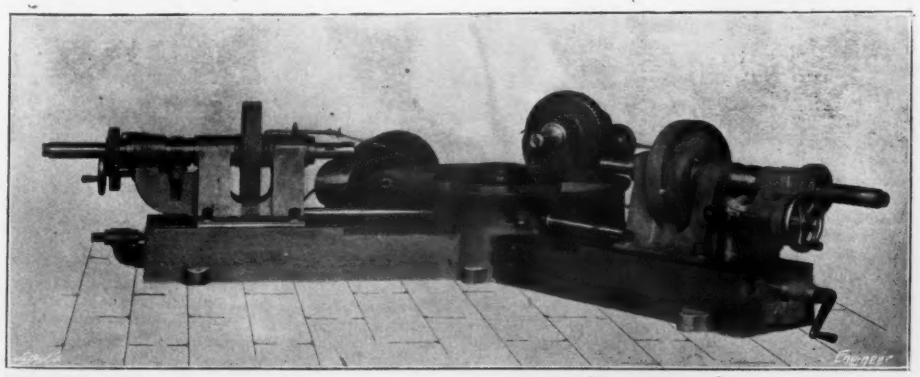


Fig. 46—WHEEL RIM DRILL—G. WILKINSON AND SONS

The driving power is obtained from a large three-speed cone carried in a bracket bolted to the left-hand upright, and through spur gearing on the horizontal shaft running along the top of the cross slide. From this shaft the spindles are driven by means of mitre wheels, vertical shafts, and spur wheels. Each spindle is balanced, and may be stopped or started independently of the others by means of a clutch actuated by a screw and lever from a hand-wheel carried on a vertical shaft in front of the head.

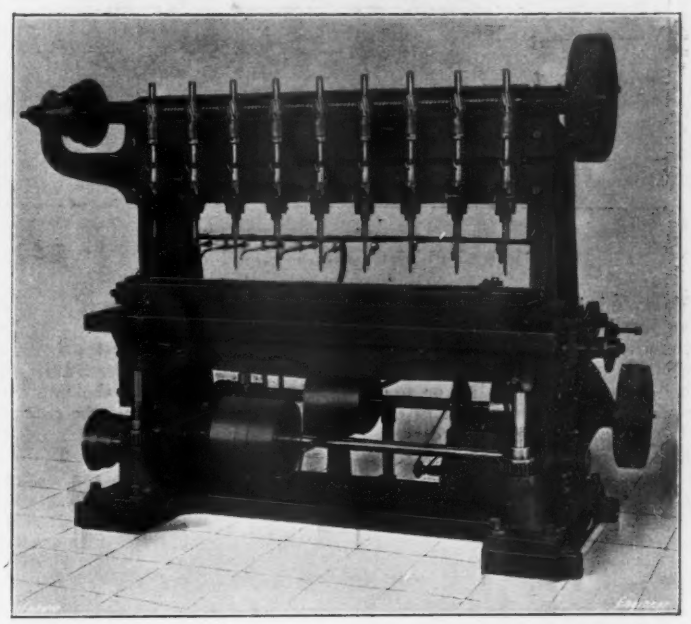


Fig. 47—NINE-SPINDLE DRILL—G. WILKINSON AND SONS

The lower portion of each spindle revolves in a steel socket fitted with gun-metal bushes, and on the face of each socket a rack is cut, by means of which the feed motion to the spindle is obtained, the motion being transmitted to the heads from a shaft carried inside the cross slide by means of spur gearing. This shaft in the cross slide is driven by a four-speed cone, keyed on to the end of the main driving shaft, through a second cone and mitre gearing carried in a bracket fixed on the side of the upright and then through a worm and worm wheel, which rides freely on the feed-shaft, but may be coupled to it by a friction clutch.

All the spindles can also be adjusted simultaneously by hand, by means of a hand-wheel keyed on the end of the feed motion shaft, the friction being released to admit of this operation. The feed motion on each spindle can also be disengaged by friction clutch, and the spindles adjusted by hand to position required when so released. The counter cone and fast and loose pulleys are carried at the back and at one end of the machine, the shaft carrying them revolving in bearings on the upright and a loose bracket. The belt shipping motion is also conveniently arranged at this end of the machine.

All the gearing is machine cut from the solid. The traverse of the spindles in this machine is 15in., their diameter 1¾in., and their speeds 90, 128, 164 revolutions per minute, with a countershaft speed of 400.

A horizontal boring and facing machine, by John Stirk and Sons, of Halifax, is shown in Fig. 41. movement on the column of 4ft. 6in., and the column has a transverse travel of 4ft. The bed is 21ft. long by 5ft. 7in. wide, and two stays for supporting a boring bar are provided. Eight cutting speeds are obtained by four changes on the belt and a back gear, and there are three gear changes of by hand power. The mitre wheels are made of forged steel, and all the gearing is machine cut. The self-acting feed can be applied to all the spindles together or to each spindle separately, and there is an automatic knock-out which stops the feed of all the spindles simultaneously.

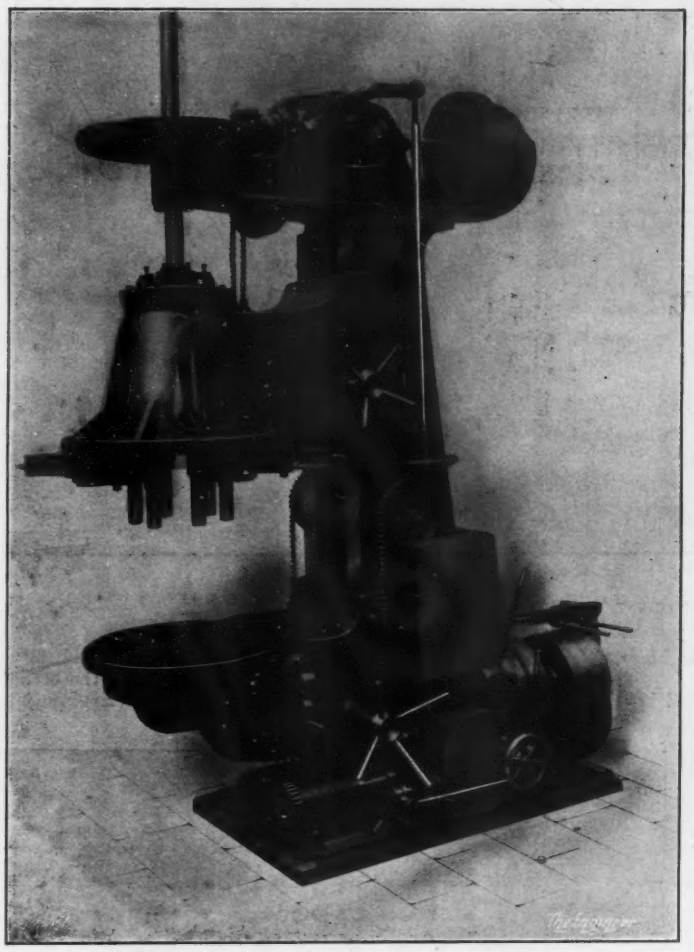


Fig. 48—FLANGE DRILL—LOWMOOR CO., LIMITED

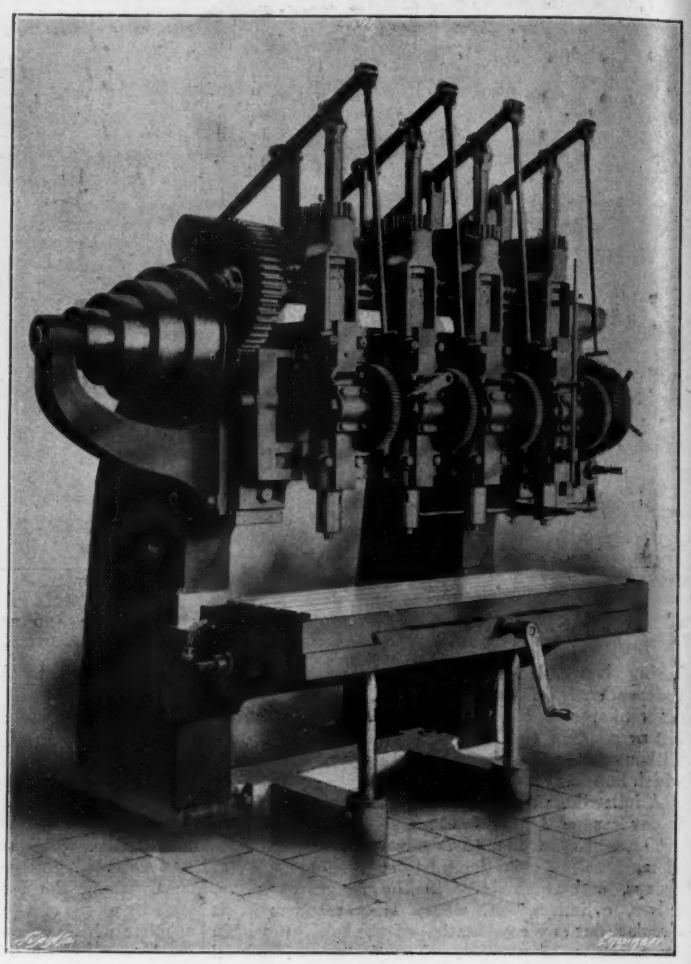


Fig. 49—FOUR-SPINDLE DRILL—J. STIRK AND SONS

The type is interesting because it represents what is practically a portable machine. It will be seen that the whole machine is virtually included in the main column with its headstock, and that it could be bolted to any suitable bed or to a tee-slotted floor, such as may now be found in several large works. The machine is electrically driven, the motor being mounted on an extension at the back of the column

The spindle is 7in. diameter, and it has a self-acting feed of 4ft. 6in. The head has a vertical feed and a trip motion. All wheels and racks are machine cut.

We illustrate also, Fig. 49, a multiple drill by the same makers. It has four spindles, 2½in. diameter with 8in. feed, the minimum distance between any pair being 8in., the maximum distance with equal spacing 14in., the distance between the two outermost drills being 42in. The width between the standards is 4ft., and the distance between the spindles and table 22in. The table has vertical and cross travel

In concluding this supplement it is perhaps desirable to say that whilst we have dealt with the machines of a large number of makers we have been compelled from limitations of space to omit descriptions of tools made by many other firms of whom more than one hold an honoured position amongst the tool makers of the world.

With several of these machines we shall deal in our next issue, of which we shall devote several pages to this purpose.

THE RECENT DEVELOPMENT OF THE LOCOMOTIVE ENGINE.

It would be impossible to treat fully of the recent history of the locomotive engine within less space than that represented by the pages of a book of some size. The following article is only intended to direct attention to certain salient points in its recent development, and to enforce the truth that the locomotive, its performance, its economies, and wastes, cannot be treated on any basis of comparison drawn with the performance of stationary or marine engines. All that is known about the locomotive engine has indeed been acquired from the experience of many men who have designed, built, and used locomotives under varying circumstances. Theorists have helped very little. It is not remarkable that opinions differ as to what is and what is not best. Furthermore, the locomotive engine is probably the most sensitive piece of mechanism ever constructed. "She has been rightly put in the feminine gender," says one authority, "because you never know where to have her." It is impossible to overrate the effect which apparently trifling conditions exert on the performance of the locomotive. This fact has, no doubt, done much to modify the rate at which development has taken place in this and other countries. When we think finality has been reached, someone makes a new departure, and no man can say that we have reached the end. We have got to the limit of height and width. Any further change in dimensions must consist in an alteration in length. But within the loading gauge it seems to be possible for developments still to take place which may result in improvements. Mr. Fry's letter and Mr. Rous-Marten's article, published in our impression for November 10th, are highly suggestive, and deserve some consideration by us.

It will be remembered that Mr. Fry's letter is a comment on an article which appeared in our editorial columns on October 13th, dealing with a Baldwin catalogue by Mr. Fry, setting forth the results of certain tests made with a four-cylinder Vauclain compound engine. In fairness to Mr. Fry we give further on an extract from this catalogue, and an engraving which shows the arrangement of the cranks and balance weights. From the greater portion of his letter we do not dissent; but there are two or three statements which seem to involve more than Mr. Fry thinks. It will be remembered that we are dealing with the relative merits of the compound and the simple locomotive. Mr. Fry argues that because the compound engine has been successful at sea, the compound locomotive must also be successful on land. In point of fact, however, very extended and costly trials, made in this and other countries, show that a general deduction of this kind is unwarrantable. It is not a matter of argument or reasoning, but of direct experience acquired on the railway. The compound engine is not certainly the best or the most economical engine under all circumstances. As we have stated, everything that is known about the locomotive has been directly acquired by experience; and experience acquired on such lines as the Great Eastern, the North-Eastern, the London and North-Western, and various other lines, was for years distinctly adverse to the compound system. That it is now succeeding is due to the influence of apparently small changes, which are of importance because of that extreme sensitiveness to which we have alluded above. Thus, Mr. Whale has enabled engines to do work which they could not do before, by making a change of at first sight little importance. The point of cut-off can be varied in the low-pressure cylinders independently of that in the high-pressure cylinders. For the result we must refer our readers to page 456 in our impression for November 10th. Again, the success attained by Mr. Fry's Vauclain compound appears to be largely due, not to compounding alone, but to the very perfect system of compensatory balancing adopted in the engine. It seems, indeed, almost impossible to overrate the effect of small matters of detail on the performance of the locomotive engine. Who, for example, would believe that thin deep coupling-rods give a distinctly freer running engine than the thick channelled bar? The latter lacks flexibility and augments friction when going round curves. It is not easy to see why, but experience says that the channelled side rods are not so good as the deep, thin rods. Again, Mr. Fry claims a gain secured by the softer blast of the compound engine. But a soft blast can be got with a non-compound engine. It is only necessary to make the nozzle big enough; but then the engine will not keep steam.

Returning to the comparison between the marine engine and the locomotive, we point out that the compound or triple-expansion engine never appears to advantage unless the horse-power and the speed remain unchanged for long periods of time. There are certain relations between cylinder capacity and boiler pressure and piston speed which are fixed by the builder at the outset. Every departure from these means a loss. The fact is so well known that it needs no demonstration. But in the locomotive the relations are constantly varying almost from minute to minute, and so is the power developed. The compound engine is not necessarily the most economical unless the indicator cards are always very nearly alike. At sea no variation in cards takes place day after day. It is not easy to get two quite alike from a locomotive. Mr. Fry tells us of an economy of 25 per cent. in water effected by a Vauclain four-cylinder compound as compared with a two-cylinder simple engine, but it does not appear that the Vauclain engine was very economical, and the non-compound certainly was not. It is very easy to beat a bad engine. We are, however, quite willing to give the Vauclain engine full credit for an excellent performance; but we are not justified in going on to say that the excellence was entirely due to compounding. That would be to say, in effect, that the recently built Vauclain engine was not mechanically an improvement on its older predecessors, a proposition which we suspect Mr. Fry would repudiate.

Turning now to Mr. Rous-Marten's report on the result of a trip between Euston and Carlisle, the whole performance was of first-rate excellence; yet we fancy that it was not better than results obtained by Mr. Rous-Marten in France, also with compound engines. We have still to learn what is the relative consumption of the compound six-coupled engine, and of the Panopea, which hauled the enormous load of 390 tons over a distance of 82¼ miles in 90 min. 24 sec., and then 75½ miles in 79 min. 40 sec.—a really magnificent performance. It does not appear, indeed, that the question of economy came into the matter at all. The engines were given tremendous loads and told to "get there" as soon as they could, and how they could; and we do not suppose that the firemen during the run could have been classed with the unemployed with any approach to accuracy.

It is quite clear that within the last five years the compound locomotive has been gaining in favour in this country. The reasons why are worth consideration. The demands of the traffic manager become day by day more and more exacting, trains augmenting in weight and in speed. The first consideration with every self-respecting locomotive superintendent is that the trains shall keep time; after that has been secured it will be time enough to think of economy. Now, it is an open secret that compound engines tried in this country have failed to keep time unless the loads were light. The causes of the defection are still in some respects obscure. The whole subject constitutes a most interesting problem, which has never yet been really touched, much less thrashed out fully. One fact of importance is that such success as was obtained was only secured by using very big boilers. If the engines had been economical in the use of steam the big boilers ought not to have been required. But this is very far from covering the whole ground. Curious as it may seem, it nevertheless appears to be the fact that the big boiler was not wanted to supply more steam, but to keep up the pressure when the engine got into trouble.

Here, again, we face one of the peculiarities of locomotive performance. Every driver knows that to keep time he must maintain his pressure. In theory, if the boiler pressure falls, it is only necessary to give the reversing lever another notch. The same average pressure will then be in the cylinders. But the change affects the whole action of the valve gear. The exhaust is modified, so is the blast. The fire suffers, and things go from bad to worse. The big boiler contains a great deal of hot water, and this will help much up a steep incline. The cut-off being still early, the steam is used to more advantage, and so on. It must also be kept in mind that all the successful compounds work with very high pressures—220 lb., and even a little more—and it is indisputable that to this augmentation of pressure is very largely due the success obtained by M. de Glehn and many others. The high pressure has enabled the engines to keep as good time as the simple engine, notwithstanding compounding.

It is not too much to say that all the compound locomotives which are satisfying modern transport demands have four cylinders. The two-cylinder compound is dead and buried; we cannot think that any more three-cylinder compounds will be built—save, perhaps, a few under very special circumstances. The cost of the new four-cylinder engine must be comparatively great. It remains to be seen if it will possess any substantial advantage over the four-cylinder simple engine, a type which has not nearly reached finality. We have said nothing so far about superheating; nor is it necessary that we should. We are dealing with types, and it is quite possible that superheating may do quite as much to help the simple as the compound engine.

A mistake is very easily made. It lies in generalising. Because a particular type of locomotive has proved successful on one line, it is argued that it must be successful on all. We have insisted on the sensitiveness of the locomotive to small purpose if the error involved in this line of reasoning be not recognised. The conditions under which a machine is worked affect its performance. No conditions can be more variable than those controlling the locomotive from minute to minute. Mr. Rous-Marten has shown us how a short incline of 1 in 75 renders profound modifications in design necessary. To modifications the locomotive responds in a way that is positively startling. A few inches less or more in the diameter of driving-wheels seems a small thing; yet these inches have before now rendered trains good timekeepers which were before always late. The addition of steam domes by Mr. Ivatt to Mr. Stirling's express outside-cylinder engines very greatly improved their performance uphill, because it enabled the water to be carried at a higher level in the boiler, and so provided a considerable store of energy, while giving more flexibility to the water supply. An error of half an inch in the setting of a blast pipe under the chimney, or a small air leak round the smoke-box door, will largely affect the steaming power of a boiler. It is for this, among other reasons, that difficulties are encountered when we attempt to assign a definite value to any change in design. Compounding is no exception. As we have pointed out, the principle does not appear to possess any overwhelming advantage. Many compound locomotives are failures; a few are successful. If compounding was really quite good, there would have been no failures, or very few. The facts show that it is not compounding, but compounding in a particular way that secures such success as has been achieved; and we have to ask why four-cylinder compounds should succeed when those with two and three cylinders fail. This is a most interesting question for discussion; we cannot attempt to deal with it fully now. It may be said, however, that the big locomotive of the future—the vast machine with a towering boiler, a chimney like a frill round a hole in the top of the smoke-box, and six-coupled driving wheels, is almost certain to have four cylinders, whether they are compound or not. An immense advantage is obtained in this way in the balancing of the horizontal reciprocating masses. The engine runs more freely than one with two cylinders. Less power is wasted by internal resistance. This must not be forgotten. It is not fair to compare a four-cylinder compound with a two-cylinder simple engine, and then say that the gain, if gain there be, is due to compounding. All the stresses are reduced. Four 15in. pistons have an area equal to that of two 21in. pistons. With an initial pressure of 150 lb., each 21in. piston has to carry a load of 52,000 lb., or, say, 23·6 tons. The load on a 15in. piston would be one half this, or under 12 tons. Is it necessary to stop to point out what is gained here in the way of reduced stress on crank axles, piston-rods, slide-bars, connecting-rods, and so on? So long as engines were of moderate dimensions, with 1000ft. or 1100ft. of heating surface, and cylinders 17in. or 18in. in diameter, little or nothing was to be gained by multiplying the number of cylinders. But it seems to us to be only a logical conclusion that if the size of the boiler is doubled, or trebled, the number of cylinders ought to be increased. It is not necessary to labour the point. Time will soon settle the question; because many four-cylinder simple engines will be built, and Mr. Drummond will very soon have at work on the London and South-Western Railway an engine of the kind, which is for the moment at all events, the last word in locomotive development.

Returning to the performance of compound engines, we give here an extract from the Baldwin catalogue. This extract refers to trials carried out with four locomotives. No. 2700 is the four-cylinder balanced engine about which Mr. Fry has written to us:—

Considering the locomotives as a whole, without separating the boiler and cylinder performance, the comparative standing is as follows:—

Engine No.	Rank.	Comparative efficiency. per cent.	Coal per I.H.P. hour.	Average I.H.P.
2700	1	100	4·30	1122
1741	2	93	4·64	966
3703	3	87	4·96	895
3701	4	85	5·05	927

If the engines are compared by cylinder performance alone, the following figures are obtained:—

Engine No.	Rank.	Water consumed per I.H.P. hour. lb.	Draw-bar H.P.
2700	1	24·37	36·78
1741	2	30·10	46·11
3701	3	30·41	49·54
3703	4	30·45	48·30

It is apparent that for all engines except No. 2700 the water rate is about 30 lb. per indicated horse-power, the average being 30·45 lb., while No. 2700 used only 24·37 lb. This saving of over

BALDWIN WHEELS AND CRANK SHAFT

20 per cent. over the simple engines includes the figures from test No. 121, on which the compound was overloaded by a twelve-car train, which it hauled on time. If this test is left out of consideration, the normal water rate for the balanced compound is 22·86 lb. of water per indicated horse-power hour, or a saving of 25 per cent. over the consumption of the simple engines.

The figures with reference to the evaporative duty of the boilers are as follows:—

Engine No.	Heating surface. sq. ft.	Total.	Water per hour from and at 212 deg. Per sq. ft. heating surface. lb.	Per lb. of coal. lb.
1741	2770	37,530	13·55	7·8
1703	2650	33,734	12·75	7·4
3701	2650	36,506	13·78	7·22
2700	2881	34,448	11·96	6·78

Other conditions concerning combustion are as follows:—

Engine No.	Draught vacuum. in.	Flue gas temperature. deg.	Flues. Length. ft. in.	Diameter. in.	Steam per I.H.P. hour.
1741	7·1	705	18 4	2¼	30·10
3703	6·7	705	16 6	2	30·45
3701	6·1	700	16 6	2	29·92
2700	4·8	718	19 0	2¼	24·37

As there was no coal record on test No. 122 with engine No. 3701, the figures for this test are omitted in these averages.

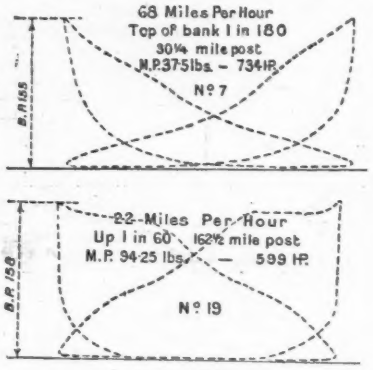
It will be noticed that engine No. 2700 shows the least economical evaporation, although the smoke-box vacuum is the lowest and the flues are the longest. Of the other engines, No. 1741, with long flues and high smoke-box vacuum, gives the highest evaporation per pound of coal. In connection with the poor showing of the boiler of No. 2700, it is worthy of mention that the crew was a new one for each day, and it was each fireman's first trip on the compound engine. No. 2700 being a compound, and, therefore, having a lower water rate, uses from 20 to 25 per cent. less steam per indicated horse-power, and still less coal, than the simple engines.

With the same-sized boiler, consequently, on his first trip with the locomotive, a fireman is likely to fire too heavily. During a test there were sometimes two or three different men running the engine, which does not tend to improve the quality of the firing. It is quite possible that the draught on this engine could be increased with good results as to the economy of the evaporation.

Figures of this kind must be taken for what they are

worth when all the conditions have been considered. Here we are dealing with averages. In so far as horse-power is concerned, inasmuch as this varied every minute, it is really of small consequence. The useful figures are those showing the total consumption of coal per trip. These the table does not give, but we see that the compound engine did the work with 23 per cent. less water than the simple engine. The saving in coal was not nearly so great. Mr. Fry attributes this to bad firing, thereby introducing an element of uncertainty. But confining ourselves to the reduction of 23 per cent. in the weight of steam needed, we have to ask ourselves how the saving was effected?

We may say here at once that we have never seen a satisfactory theory of the compound locomotive. The argument for it usually takes this form:—steam is discharged from the cylinders of a non-compound engine at a fairly high pressure. It retains much energy that might be utilised. The compound engine exhausts at a much lower pressure steam which possesses less available energy. Occasionally something is said to the effect that, owing to the smaller range of temperature in the cylinders, initial condensation is reduced; but no one insists on this factor. Let us confine ourselves to the first proposition, and ask if it is true? In point of fact it is not true for any but very low speeds. We give here two diagrams taken from a Great Southern and Western engine with Marshall's gear. It will be seen


68 Miles Per Hour
Top of bank 1 in 180
30¼ mile post
M.P. 375 lbs. — 734 IP.
No 7
B.P. 155
22 Miles Per Hour
Up 1 in 60 162½ mile post
M.P. 94·25 lbs. — 599 IP.
No 19
B.P. 150

LOCOMOTIVE CARDS

that the terminal pressure was little or nothing above the atmosphere, and that so far is the steam from containing available energy, that it has to be pushed out of the cylinder by the advancing piston during the exhaust stroke. The sharp beat of the exhaust is the result of compression. As far as expansion is concerned, compounding can give no help, save indeed for locomotives hauling heavy trains at low speeds. Economy then must be sought in some other direction. It is worth while to add that next to nothing has been done in the way of building compound goods engines. The reason why remains to be ascertained. There are many high-speed land engines running as quickly as locomotive engines; but they give a diagram much fatter than that of the railway engines. The fact that theory helps us so far not at all to decide whether a locomotive should or should not be compound has, no doubt, checked the progress of the system. It is useless to advocate it unless we are prepared to explain why it should use less steam than a simple engine. We can only fall back on facts, and say, "Explain it how you will, or do not explain it at all, the compound locomotive is more economical than the non-compound on such and such a railway." In its way this argument is very convincing, but it leaves a sense of something wanting. The problem must be attacked with a determination to work out thoroughly the nature of the heat and work exchange taking place in the cylinders. We have wire-drawing, we have practically continuous expansion. The whole of the available energy is got out of the steam, but a large part of it is expended in effecting compression. It seems as though it is to the avoidance of this factor that we must look for improvement. If it can be shown that in the compound locomotive less work is done on the steam and more by it, we have at once the explanation sought for. But the question must be handled with a narrow view. Generalities will not apply. It ought to be steadily kept in mind that the locomotive engine is *sui generis*, and must be dealt with accordingly.

It will be seen that in what we have written we have confined our attention to the engine; we have said nothing about the boiler. If we have succeeded in setting our readers thinking on somewhat novel lines, our present purpose has been accomplished.

THE ORGANISATION OF A DRAWING-OFFICE.

By W. O. HORSNAILL, A.M.I. Mech.E., A.M.I.E.E.

No. I.

IN these days of fierce competition economy is essential in the drawing-office as well as in other departments of a large engineering works, but it is important that the money saved in this way shall not be more than counterbalanced by additional expense in the shops. The main part of the system described in this article is applicable to drawing-offices dealing with all kinds of engineering work; but better to illustrate the methods put forward, an office containing accommodation for some twenty draughtsmen and tracers will be described, and their work will be assumed to consist in designing motors and dynamos from 2 horse-power up to the largest sizes, and issuing instructions to the shops in connection with orders for such machines.

The office and furniture.—The lighting, heating, and ventilating need not be touched upon at any great length here, as it will be assumed that such matters have been effectually dealt with by the architect. The heating is perhaps the most important of the three, as it is impossible to do efficient head work in a cold office, and it will be found that men engaged upon work of this nature require a higher temperature in which to work than will serve for others whose duties keep them moving about. Before deciding upon the size of the office, it will be necessary to consider what furniture and fittings are required. An office for the chief draughtsman should be provided as near the middle of one side of the drawing-office as possible, the floor should be raised at least 12in., and a glass partition, having a door in a convenient position, should be built round the three open sides.

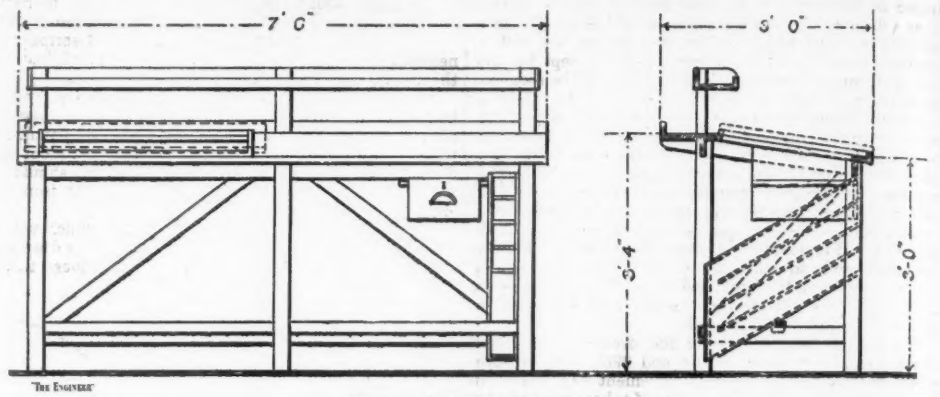


Fig. 1—DRAUGHTSMAN'S DESK

Next to this office a space should be provided for a type-writing clerk, who will deal with correspondence and post up the drawing indexes and other records. This clerk should be given ample accommodation, consisting of:—(1) A desk having a book rack with a shelf for baskets above and two lock-up drawers in which to keep

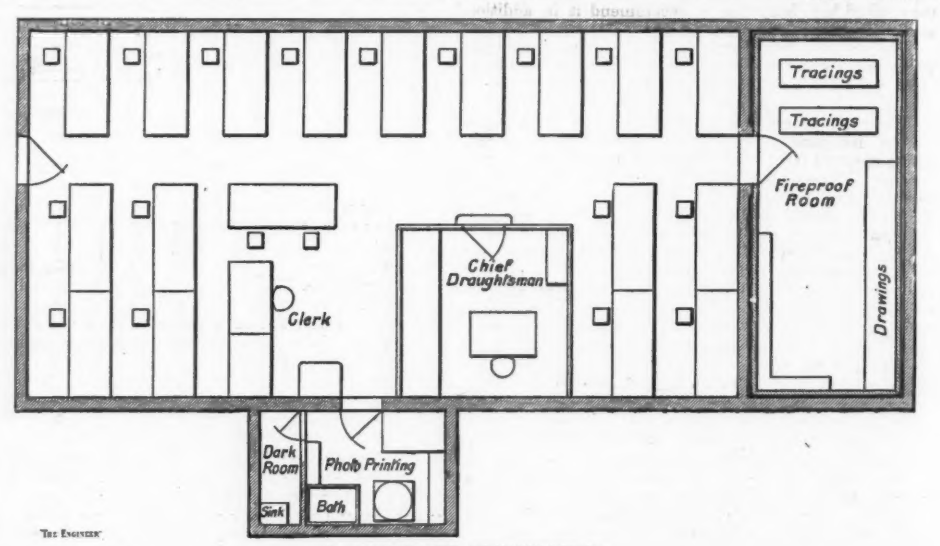
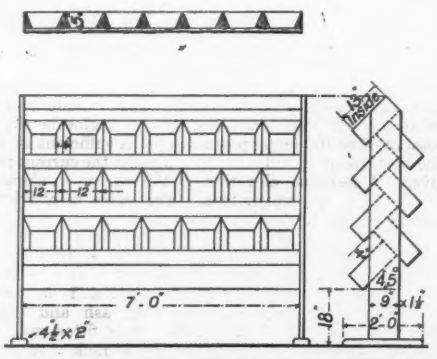


Fig. 2—PLAN OF DRAWING-OFFICE

pencils, drawing-pins, and other office requirements; (2) a typewriting desk; (3) a large table or bench for order files, record books, &c., in current use; (4) a lock-up cupboard for storing drawing, tracing, and photo paper, linen, &c.

Each draughtsman will need a drawing desk, in which the following requirements should be provided for:—(1) A space for the drawing-board; (2) room alongside for a full-sized drawing; (3) a lock-up drawer for instruments and draughtsmen's private effects; (4) a shelf at the back and above the board for holding instruments and paper in use; (5) pigeon-holes for rolled-up drawings.



Figs. 3 and 4—TRAYS AND RACKS FOR TRACINGS

Various forms of drawing desks are already on the market, and may be adopted if they meet all the above requirements, and if—which is of great importance—they allow a clear view over the whole room to be obtained from the chief draughtsman's office. It may, however, be found cheaper to have the desks made from the design given in Fig. 1; such desks give all the accommodation required, and they do not obstruct the view to any important extent. The hole under the drawing-board is purposely arranged to prevent any accumulation of papers, &c., in this position, where they are apt to be overlooked; at the same time, an appreciable amount of timber is saved, thus reducing the cost.

It may be mentioned here that it is the custom to provide the draughtsmen with drawing boards, T-squares, drawing pins, rubber, eraser, penholders and nibs, colours, paper, and linen. Instruments, scales, and set squares are provided by the men themselves, excepting special instruments, such as a planimeter, trammel heads, and the like, which are only occasionally in use. Drawing boards and T-squares should be of the best quality, with ebony edges. In addition to the above desk, each draughtsman will require a stool upholstered on the top and covered with leather, and a footstool, the latter being made as required to suit various heights.

Strong room.—A fireproof room should be built adjoining the drawing-office, and opening into it by means of an iron door. In addition to the latter a wooden half door with flap will be required. This room will contain racks for drawings and tracings, and shelves for record files, index books, letter files, &c., as may be found necessary.

Printing room.—This room should also open out of the drawing-office, and it should be provided with the following furniture and appliances:—(1) A cylindrical electric printing frame, complete with lamp, &c., for doing two full-sized prints in one operation; the type of frame mounted on trunnions, enabling it to be tipped into a horizontal position, will be found handier than a fixed cylinder; (2) a cutting bench having a piece of glass let into the top, and with pigeon holes below for drawings, &c.; (3) a lead-lined water bath, with water tap and drain pipe; (4) lock-up cupboard for cameras, chemicals, &c.; (5) shelves for negative boxes. (6) Dark room with ruby window, sink, and water supply.

Fig. 2 shows a plan of the drawing-office and other rooms described above. Of course, the shape of the room and the positions of the strong and printing rooms may be modified to suit varying conditions.

Description of work.—The work will consist of:—(1) Making shop drawings of standard machines, and the tools for their manufacture; (2) designing special machines and issuing shop instructions for customers' orders; (3) designing special machines for tenders; (4) issuing shop instructions for stock orders. Standard machines up to the largest sizes for which a complete set of tools and jigs are provided should not be designed in the drawing-office. This work can be better done by a special designer, who will spend most of his time in the shops, and who can give up his entire time to the study of special tools and the cost of material to be obtained from outside sources. This man will apply to the chief draughtsman for an assistant to make any drawings he requires, or to issue instructions for an experimental machine. It is only after a new design of machine is entirely approved that it should be handed over to the drawing-office to make the working drawings.

The mechanical design of the larger machines should be in the hands of the chief draughtsman, who should

keep closely in touch with the electrical designer on the one hand and the shop manager on the other. This work, together with the general management of the office, will take up his entire time, and he should not be expected to supervise designs of building work, machine tools, &c., which may be required from time to time. If such work be done in the drawing-office, the design should be controlled by whoever is directly responsible.

Drawings and tracings.—All standard drawings and those likely to be used for more than one order should be traced on linen, and these linen tracings will be referred to as "drawings." Each drawing should be given a consecutive number, which can be stamped on the bottom left-hand corner, a set of rubber type being kept for this and other similar purposes. The drawings will be mounted on sticks, and stored in the strong room in the following manner:—Each stick is made up of two pieces of ¾in. half-round wood beading, held together by four wood screws, the linen being inserted between the halves of the stick. One piece of beading is 30in. long, the other being 2in. longer, and they are screwed together with the top ends flush with each other, thus leaving 2in. of one half stick overlapping at the bottom, upon which the number can be stamped. It is necessary to leave 6in. of blank linen at the stick end, to allow of printing from the tracing without removing the stick, and it is advisable to leave 2in. blank at the left-hand end, as this edge is inclined to curl over and become damaged.

For the purpose of storing the drawings, millboard tubes, 1¼in. in diameter inside, and 29in. long, are provided, and may be kept in any convenient form of rack in the strong room. The lowest row of tubes should be at least 12in. from the floor, and the top rows must be within reach of a medium sized boy. The above method of storing linen tracings is much to be preferred to the system of keeping them in drawers, some of the advantages being as follows:—(1) Any tracing can be referred to without disturbing the others; (2) all tracings can be checked over quickly to ascertain if they are in proper order, or if any are missing; (3) tracings are not so liable to get damaged, as most of them are rolled up; (4) time saved in taking out and replacing. When it is remembered that the racks for holding the tubes cost less than half the money which would be expended in chests of drawers, it will be apparent that the method has cheapness to recommend it in addition to the advantages enumerated above.

All drawings for special or experimental machines which will only be used for one order should be traced on paper for the sake of cheapness. These drawings will be referred to as tracings, and will be given a distinct set of consecutive numbers to themselves, which will be stamped on the left-hand bottom corner as for the drawings. Prints received from outside will also be included in this category. These tracings are kept in the strong room in the following manner:—Trays are made as shown in Fig. 3. In each division loose paper leaves are inserted, each leaf being consecutively numbered, thus providing a definite place for every tracing. The tracings are folded to the required size. These trays may be any convenient length, and they should be held as shown in Fig. 4.

Before leaving the subject of "drawings and tracings" it will be necessary to explain the method of classifying them under various headings, with a description of the indexes required for this purpose. For all electrical machines the best title is the size formed by the diameter and length of the core, prefixed by A or C for alternating or continuous current machine respectively, thus:—A 40 × 12, C 72 × 18, and so forth. Other titles will be necessary, such as: Buildings, Engines, Machine Tools, Various. A list of these titles should be hung up in a conspicuous position, and each drawing or tracing should be marked with one of them, followed by a sub-title as:—Shaft, end cover, commutator, general arrangement, &c.

A card index will be required for drawings and another for tracings, each containing a consecutive list of numbers, with date of entry, title, and sub-title. These numbers will be obtained in the following manner:—Manifold tickets are printed having spaces for drawing or tracing number, date, title, sub-title, and initials of draughtsman. These tickets are filled up, excepting for the number, and taken to the clerk, who gives them the next number, and files one copy for entry in the index at any convenient time. The files for these tickets should be kept on the clerk's desk, thus enabling the draughtsmen to take their own numbers in his absence. In addition to the above, card indexes will be required, classified under the titles, these indexes being posted up from the number index cards already described.

Patterns.—Each pattern should have a number assigned to it in the drawing-office and marked on the drawing, these numbers being obtained by means of manifold tickets, as for drawings and tracings, the only difference being that the titles will be transposed—that is to say, that the patterns will be classified under the drawing sub-titles, such as bearings, end covers, commutator brushes, brush rockers, &c., the size of the machine following as a sub-title in cases where the casting belongs exclusively to one size. For bearing bushes, brush holders, pulleys and the like, which may be used for various sizes and types of machines, the sizes of the actual parts should be given as sub-titles thus:—Bearings, 6 × 18; pulleys, 20 × 10. A consecutive number index will be required for patterns as for drawings, and an index classified under the titles. Where patterns are altered, a new number should always be taken, and a note marked on the drawing giving the old pattern number, thus:—Pattern No. 1844, altered from Pattern 1078.

Machine numbers.—Each machine will be given a consecutive number, which will be taken from a machine index. This book should give the following particulars:—Machine number, date, size, and order number.

Photographs and blue prints.—A photographer will be permanently employed taking photographs of various machines and making prints from drawings, &c. If much photographic work be called for, he will require a boy to assist him. Negatives, and prints from them, should only be taken in response to a signed note from the chief draughtsman; if this rule be not strictly enforced, unauthorised prints are likely to be made, and find their way into the hands of persons who have no right to them. The photographer should be instructed to make prints from drawings only on written and signed authority from one of the leading draughtsmen; this authority should be given in the form of a leaf from a manifold book, thus forming a check on the number of prints taken. A photograph index will be required containing the following particulars of each negative:—Consecutive number; title—same as for drawing index; further description if necessary; date. An index will also be required, in which the photographs are classified under their titles.

The strong room.—All drawings, tracings, record books, &c., will be kept in the strong room described above, and a smart boy will be continually in attendance to issue drawings, &c., as required. The half-door and flap should be kept fastened, and no one should be allowed in this room without a special permit from the chief draughtsman.

Tough paper tickets should be provided, which will be filled up and signed by draughtsmen requiring drawings, tracings, or books from the strong room; these tickets will be retained by the boy until the articles are handed back, when they should be returned and destroyed. Every Saturday morning all drawings, tracings, and books, should be returned to the strong room and put in their right places, and the drawing and tracing racks should be checked over by a clerk to ascertain if any are missing. This latter precaution is most necessary, as it will be found that drawings and tracings disappear to an alarming extent unless a strict watch be kept upon them.

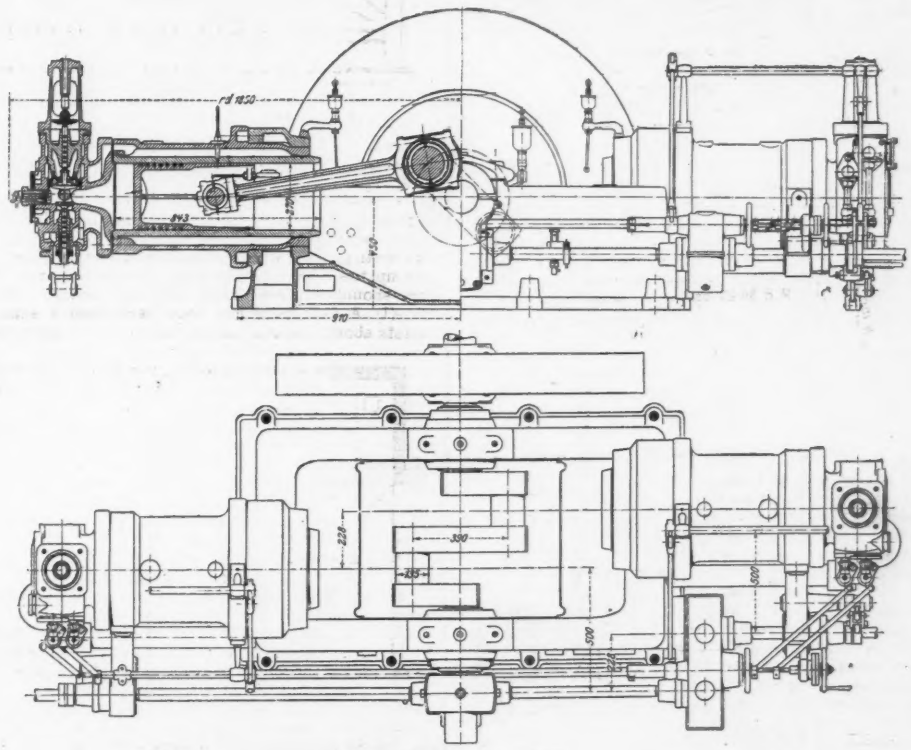


FIG. 1—MARINE GAS ENGINE

A SUCTION GAS PLANT BOAT.

ONE of the largest examples of the application of suction gas engines to the propulsion of boats for river navigation is furnished by the river boat Lotte, a barge with a flat wooden bottom 189½ft. long and 15ft. beam, carrying 240 tons upon a draught of 6½ft. This was originally intended for service on the Elbe, but has been retained by the builders of the engines, the Otto Gas Engine Company, of Deutz, for their own carrying trade between Cologne, Antwerp, and Rotterdam. In order to obtain good balance for the engines, a four-cylinder horizontal arrangement has been adopted. The engine developes a total of 80 to 100 horse-power, which is sufficient to drive the boat about 3½ miles an hour against the current in the river. A sectional elevation of the engine as shown in Fig. 1 needs no explanation. The valve mechanism is clearly shown in another illustration, Fig. 2. The screw shaft is connected with the engines by a friction coupling. The gas producer is placed in front of the engine-room, from which it is separated by a bulkhead with sliding doors, which can be closed during the operation of cleaning the grate from ash and clinker. The screw is 4ft. 3in. diameter, and is fitted with four blades reversible in direction by a rack and pinion motion; the reversing rod ends in a series of toothed racks which gear into corresponding pinions on the axes of the reversible propeller blades. The power required for reversing is taken from the main engine shaft by a combination including a friction coupling, differential gear wheels, and toothed clutches and helical gears, which screw the rod backward and forwards, as shown in the sketch, Fig. 3. This is brought into action by throwing the clutch into the back or forward gear as required when starting it by the frictional coupling with the main engine. The motion necessary for any required pitch is marked on a divided scale, and this is varied according to the action of the engine, the pitch being gradually increasd until the full load is attained.

For starting as well as for working the fan blower on the cargo winch on deck, a small benzine engine of 6 horse-power is provided, which starts the main engine by a frictional connection with the fly-wheel and keeps it running until ignition in the cylinder has commenced. When the engines have been standing for a long time the fan blower is used for a few minutes to enliven the combustion in the producer. This, as well as the deck winch, is driven by a belt and a line of overhead shafting.

Up to the present time eleven different boats with suction gas plants have been built by the Deutz Company, the horizontal arrangement being used for the larger sizes, with two cylinders up to 45 and four for 65 to 90 horse-power, the latter running at 275-325 revolutions per minute. For smaller boats the ordinary vertical marine type of engine is used, with two, three, or four cylinders, mineral oil or alcohol being used as fuel. Boats of smaller power are largely used in Holland, and it is said that 280 of these, together developing 2500 horse-power, have been supplied to that country by this firm, out of a total of 320, with 4000 horse-power of engines.

Cargo boats of the kind described above have been found to be extremely economical in working, the following results having been attained in the Rhine navigation between Cologne and Rotterdam—a distance of about 190 miles. With a boat of 250 tons carrying capacity, with an average load of 200 tons and engines of 100 horse-power, costing about £2250, the average time required for the

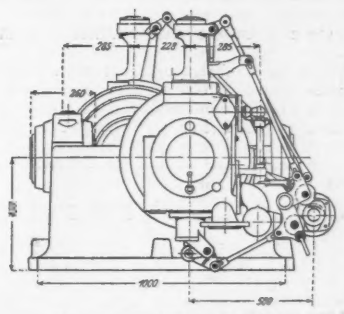


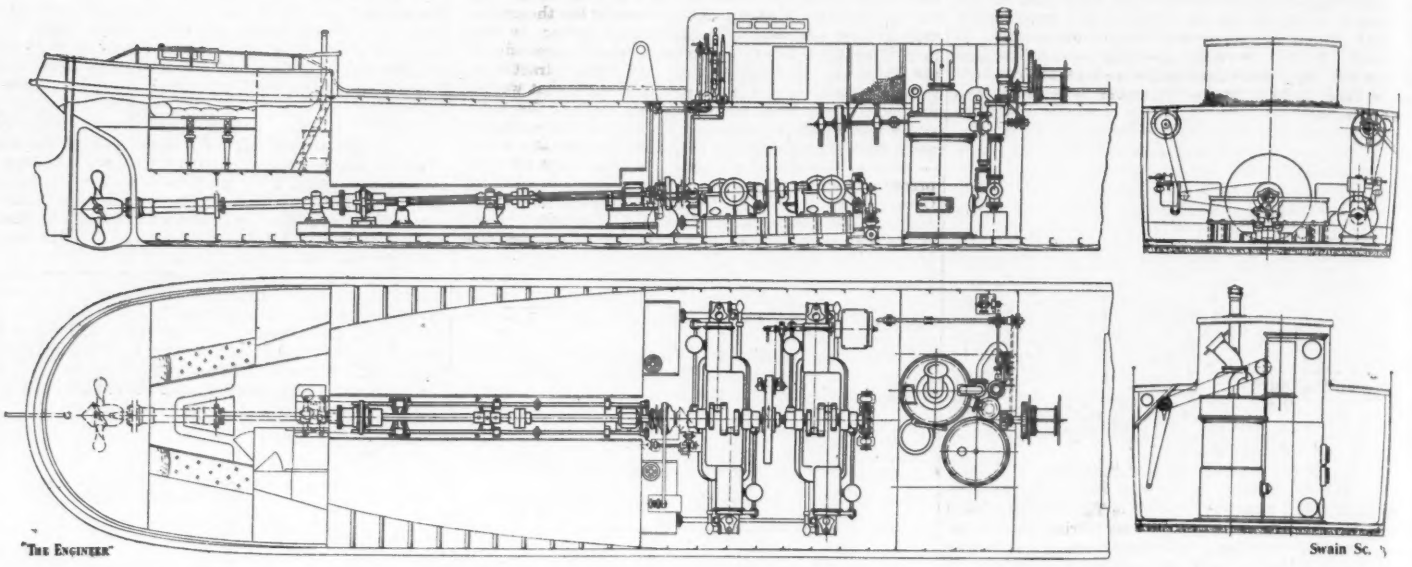
FIG.—2 END VIEW OF ENGINE

round trip, inclusive of all stoppages, is fourteen days, thus giving twenty-six voyages in the year.

	£	s.	d.
Depreciation on hull, 5 per cent. on £1000 ...	50	0	0
Depreciation on engines, 10 per cent. on £1250	125	0	0
Interest on capital, 5 per cent. on £2250 ...	112	10	0
Insurance, 4s. per cent. on £2250	2	5	0
Navigation dues, £6 trips at £7 10s.	195	0	0
Fuel (anthracite at 20s. per ton), burnt at the rate of 1·32 lb. per horse-power hour for 75 hours per round trip, 50 hours upstream and 25 hours downstream—117 tons	117	0	0
Lubricating material and cotton waste	48	15	0
Wages	320	0	0
Total annual outlay...	1002	10	0

The cargo carried was 200 × 26 = 5200 tons for a distance of 375 miles, or 1,950,000 ton-miles, corresponding to a cost of 0·1235d., something less than half a farthing, per ton-mile. The corresponding cost of carriage by the ordinary river steamboats is about one-half more, on the lowest railway freight about five times as much. On the Saarbrücken Mullhausen Canal, where the round trip of 170 miles required 30 days, including 9 days'

RIVER BOAT WITH SUCTION GAS ENGINES



detention and 9 days' returning light, the cost, with the gas engine in a boat of 240 tons, with a 16 horse-power engine, was only two-thirds of that of horse traction, the boat making eleven journeys in the year by the former as compared with seven by the latter method.

Above we give an illustration of the general arrangement of the machinery of the barge we have just described. The plant is very compact, and takes up little space. Attention should be directed to the small amount of room required for fuel storage. The arrangement of the propeller shaft can also be seen clearly in the illustration. We are indebted for the above particulars to the *Zeitschrift des Vereines Deutscher Ingenieure*.

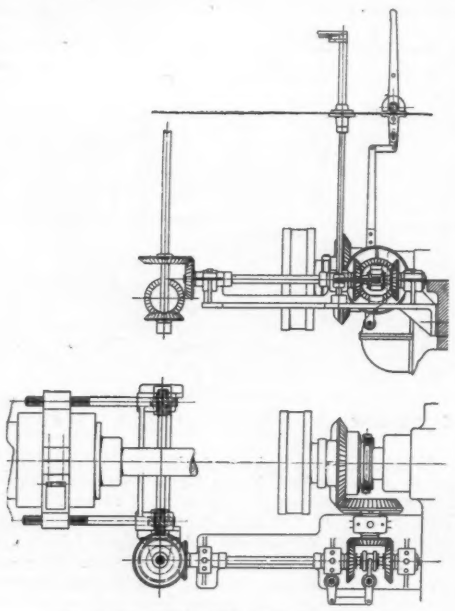


Fig. 3—STARTING AND REVERSING GEAR

CIRCULAR SAWS FOR METAL.

SPECIAL designs of circular saws with inserted teeth are now being built for cutting steel castings and other heavy work in the United States. For such work a heavy cut or feed is desirable, as the surface of the metal contains more or less sand, which grinds away the cutting edge, while with a deep cut the cutting edge works in the clean solid metal. A heavy feed necessitates great strength in the saw teeth, but in many machines the inserted teeth have not been able to stand up to the work, and the breaking of a tooth is often attended with some damage to the saw blade or disc. In the Taylor and Newbold saw the aim has been to provide inserted teeth which should have a maximum cutting strength, and a maximum resistance to abrasion, allowing at the same time for the immediate removal of broken or damaged parts, and protecting the saw blade from injury as far as possible. The teeth are alternately broad and narrow, the narrow teeth being set out farther than the broad teeth, to divide the cutting between. The teeth are ground in a Taylor grinding machine to an exact shape by means of a former, so that all the broad teeth are exactly alike, and the narrow teeth also. The teeth are held in place by wedges in the slots of the saw blade. They are made of high-speed steel hardened by the Taylor-White process. A 36in. saw after two weeks' constant and severe service cut through a steel forging 14in. wide and 9in. thick —0·35 per cent. carbon—in seventeen minutes. These saws are used mainly in steel foundries, forge shops, and rail and shape rolling-mills, and of course special care has to be taken to clamp the work to resist the tremendous cutting pressure without slipping.

A NEW WORK DIAGRAM FOR GASES.

By FRANK FOSTER, B.Sc.

THE diagram about to be described has been devised to illustrate the actions of, and simplify the calculations for, gas turbines, turbo compressors, gas engines, air compressors, and hot air engines. There are really two diagrams, either of which can be made to cover the whole range indicated above, but one of the diagrams is particularly suitable for turbine work and air compressor problems when there is no appreciable clearance in the cylinder and no compression at the end of the return stroke. The other diagram is particularly suitable for ordinary gas engine problems. We will describe the former diagram first, and point out how it can be made to cover ordinary gas engine problems.

In the first place we shall assume that if:—

p = absolute pressure in pounds per square foot,
u = volume of one pound of gas in cubic feet,
T = absolute temperature in degrees Fahrenheit,
= 461 + temperature Fahrenheit,
R = a constant.

Then $$p\,u = \mathrm{R\,T}$$

This law holds with fair accuracy in most practical cases. If, however, some other law holds the method of constructing and using the diagram about to be described would be unaltered save as to details. The following Table I. gives the values of R for different gases:—

TABLE I.

Gas.	Symbol.	R.	k_p	k_v	K_p	K_v	n	m	B
Air	—	53·18	·238	·169	184·5	131·4	1·407	·711	—
Oxygen	O	48·2	·218	·156	169·5	121·3	1·398	·715	—
Hydrogen	H	770	3·406	2·416	2650	1880	1·410	·710	61,260
Nitrogen	N	55·5	·244	·173	190	134·5	1·410	·710	—
Carbonic acid	CO_2	48	·216	·154	168	120	1·403	·713	—
Carbonic oxide	CO	56	·248	·176	193	137	1·410	·710	4,370
Marsh gas	CH_4	95	·593	·470	461	366	1·26	·793	26,400
Olefiant gas	C_2H_4	—	·404	—	314	—	—	—	21,300

R = $K_p - K_v$
k_p = Specific heat at constant pressure in B. Th. U.
k_v = Specific heat at constant volume in B. Th. U.
K_p = Specific heat at constant pressure in foot-pounds.
K_v = Specific heat at constant volume in foot-pounds.
$n = \dfrac{k_p}{k_v}$ . . . (adiabatic expansion).
$m = \dfrac{1}{n}$
B = B. Th. U. liberated by combustion in oxygen.

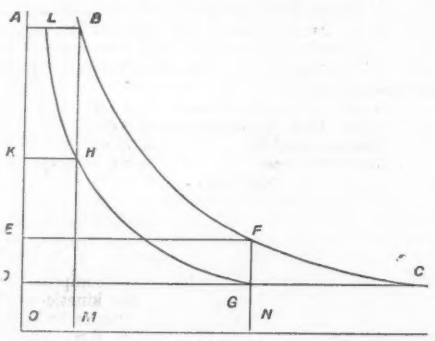


Fig. 1.

The mechanical equivalent of heat has been taken as 778, so that, for instance, $K_p = 778\ k_p$.

Now, if in Fig. 1 B C is the expansion curve of an ordinary pressure-volume diagram whose equation is of the form $p\,u^n$ = constant or $p^m\,u$ = C (constant) where m is the reciprocal of n, then the area of the diagram A B C D between the pressures p_1 and p_2 is—

$$W = \frac{p_1 u_1 - p_2 u_2}{1 - m} \quad . \quad . \quad . \quad . \quad (1)$$

$$= \frac{(C\,p_1^{\,1-m} - p_2^{\,1-m})}{1 - m} \quad . \quad . \quad . \quad (2)$$

$$= \frac{\mathrm{R\,(T_1 - T_2)}}{1 - m} \text{ . foot-pounds . } (3)$$

Further, $$C = p^m\,u = p\,u\,p^{m-1}$$

$$= \frac{\mathrm{R\,T}}{p^{1-m}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If p and T are known at some point—say, the commencement of the expansion or compression—we can determine C.

Fig. 2 shows our new work diagram. Temperatures, and other quantities to be mentioned later, are measured vertically, and the values of W as determined by the above equation are measured horizontally. The line marked p = 100 represents a constant pressure line for a pressure of 100 lb. per square inch—14,400 lb. per square foot as used in the calculations—and is determined as follows:—We assume some final pressure p_2, usually atmospheric—14·7 lb. per square inch, or 2116 lb. per square foot—and from equations (2) and (4) determine the relation between W and T. As a matter of fact, the curve so obtained is a straight line through the origin of absolute temperature, so that it is only necessary to determine C from equation (4) for one—any—temperature T. Inserting this value in equation (2) we obtain the value of W at the above temperature, and then draw a straight line through the origin of absolute temperature. The pressure line p_2—in this case atmospheric—will coincide with the axis of temperature. It may be worth mentioning here that the spacing of these constant pressure lines is not uniform.

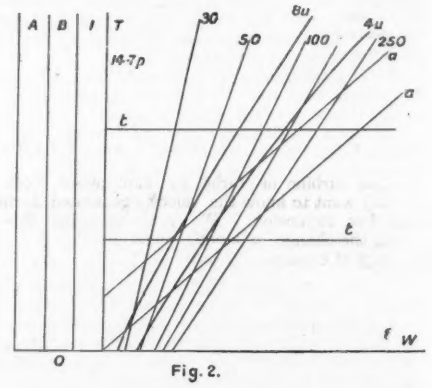


Fig. 2.

We can now draw in the *constant volume lines*, for we know that

$$p\,u = \mathrm{R\,T},$$

and we have the values of p and T already on the diagram. These constant volume lines are marked u on the diagram.

Isothermal lines are, of course, horizontal. They connect points of constant $p\,u$. The values of these products are shown on one of the vertical scales of the diagram and

denoted by I. Suppose the gas to expand at (Fig. 1) constant volume (E F) from the pressure O E to the pressure O D, then on our diagram we look along the corresponding pressure lines and note where they are intersected by the proper constant volume line. The corresponding I's—their difference that is—give us the work done in this expansion. It may be noted that the value of I is also equal to R T, and that if desired the scale of temperature may be made to serve the same purpose as a scale of I.

We saw that

$$W = \frac{R\,(T_1 - T_2)}{1 - m}$$

or

$$\frac{W}{T_1 - T_2} = \frac{R}{1 - m} \quad . \quad . \quad . \quad (5)$$

This shows that the line giving the relations between p, u, and T during the expansion—corresponding to the expansion line B C of Fig. 1—is a straight line of constant inclination for any given gas and value of m. Hence we can, if we desire, draw in a series of parallel *expansion lines*, making an angle to the horizontal axis of W, whose tangent—to the proper scales—is given by Equation (5). The lines marked a in Fig. 2 have been so drawn.

Suppose that during the expansion down to a temperature T_2 not all the energy W has been usefully expended, but that a fraction of it x W has been dissipated as heat, raising the temperature to T_3. Then we know that

$$Kp\,(T_3 - T_2) = x\,W = \frac{x\,R\,(T_1 - T_2)}{1 - m} \quad . \quad (6)$$

from which we can readily determine T_3. We see that if the fraction x is constant at all points during the expansion, then the new and true expansion line passing through the temperatures T_3 as calculated above will be a straight line. In the particular case where no useful work is done, all the energy W being converted into heat—this occurs when the gas is throttled—we have

$$Kp\,(T_3 - T_2) = \frac{R\,(T_1 - T_2)}{1 - m}$$
$$= K\,p\,(T_1 - T_2).$$

Evidently, then, $T_1 = T_2$, and these throttling lines are isothermal or horizontal lines—marked t on the diagram.

These throttling lines and lines of partial throttling—x less than one—are especially useful in turbine work.

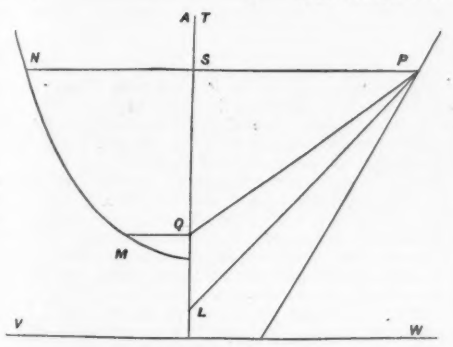


Fig. 3.

Again, we know that if we add a quantity of heat H to the gas its temperature will rise by an amount equal to

$$\frac{H}{k_p} \text{ if at constant pressure,}$$

and

$$\frac{H}{k_v} \text{ if at constant volume.}$$

If these quantities of heat were given in terms of work units we should use the corresponding specific heats.

We can then place scales A and B in Fig. 2 to represent the heat—or its equivalent in work units, which is often more convenient, although both scales may be used—which must be added to give the required rise of temperature at constant pressure and constant volume respectively. These scales will be proportional to the temperature scale. For instance, the constant volume scale will have a value equal to k_v T, if in heat units.

For many purposes it may be desirable to consider the expansion as adiabatic, in which case the index m has the value given in Table I., and the expansion lines a are *adiabatic lines*. Where, however, as is usually the case in practice, the expansion is not adiabatic, the construction of the diagram is on the same lines, it being remembered, of course, that m has not now the value given in Table I.

For gas turbine or turbo air compressor work we frequently want to know the velocity generated during a certain free expansion. We can determine this by equating the change in kinetic energy to the change in the energy of expansion, thus:—

$$\frac{v_2^2 - v_1}{2g} = W \quad . \quad . \quad . \quad . \quad . \quad (8)$$

If part of this is dissipated as heat, then we have—

$$\frac{v_2^2 - v_1^2}{2g} = (1 - x)\,W \quad . \quad . \quad (9)$$

x being the fraction dissipated as heat.

For convenience in dealing with turbine problems, it will be advisable to draw in a series of velocity curves such as is indicated by M N in Fig. 2. The axis O A—constant pressure heat scale—is also the scale of kinetic energy W. These velocity curves are all drawn from the same template by merely sliding it up and down the axis O A.

In order to illustrate the uses of this diagram we will consider one or two practical cases.

First consider the expansion in a gas turbine. If the gas neither receives nor gives out heat during expansion, the expansion curve used for the purpose of constructing the diagram will be adiabatic. If, however, the walls, or leakage, cause either loss or addition of heat to the gas during expansion, then we cannot consider the theoretical expansion as adiabatic. We may still, however, be able to estimate the value of the index m from a knowledge of the amount of this heat exchange. A certain fraction of the kinetic energy is converted into heat, so that we can draw in the true expansion line P Q as well as the theoretical—no loss—expansion line P L; it must be remembered that in turbine problems we do not use the actual expansion line for the purpose of drawing in our constant pressure lines. Draw the throttling line P S. Project Q on to the velocity curve M N, so that M Q—usually zero—is the initial velocity of the expansion. Then N S is the final velocity of the expansion. If the total

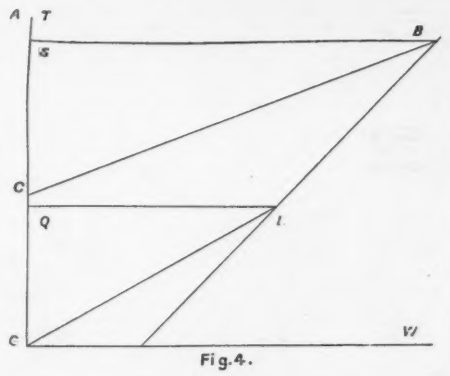


Fig. 4.

expansion is in several stages then we mark off from S along S Q the actual amounts of indicated work—on the scale A—done in each of these stages. Projecting back on to the true expansion line P Q, the intersections give us the pressures, volumes and temperatures at each stage. For purposes of determining the velocities, each stage must now be considered as a separate expansion. The diagram can also be made to show the changes in pressure, volume, and temperature in each stage caused by the losses in that stage. At present the diagram only shows the conditions at the entrance to each stage. The method of modifying the diagram for this purpose will suggest itself to the reader, so that we will pass it over.

If (Fig. 1) the complete cycle of a gas turbine is as follows:—

G to L, compression of gas;
L to B, receives heat H at constant pressure;
B to C, expansion in turbine.

Then the cycle will be represented on our work diagram as follows (Fig. 4):—

G to L, compression of gas to pressure L B;
L to B, receives heat H (equal to Q S) at constant pressure;
B to C, expands to atmospheric pressure.

The expansion lines B C and G L are the true expansion

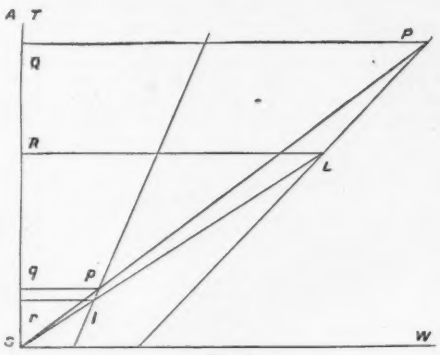


Fig. 5.

lines. If the compression is by a turbo compressor the inclination of G L will be greater than the inclination of B C.

Then measuring all quantities on the constant pressure heat scale A, we have:—

Work done in compression = G Q;
Work done by expansion = S C;
Heat received H = Q S;
Net work done = S C − G Q;

$$\text{Efficiency} = \frac{SC - GQ}{QS}.$$

The lines G L, L B, and B C give us the pressures, volumes, and temperatures at all points during the cycle.

Let us now briefly consider the action of a turbo compressor—Fig. 5. S L is the theoretical compression line to the pressure L P. A fraction of the kinetic energy is dissipated as heat raising the temperature to P, so that the true expansion line is S P. Then R S—scale A—is the theoretical work of compression and Q S the actual work of compression. Therefore the efficiency is equal to $\frac{RS}{QS}$. If the pressure had been $p\,l$ instead of P L, the efficiency would have been $\frac{r\,S}{q\,S}$, and a little consideration of the geometry of the diagram will show that the latter efficiency is higher than the former, showing that turbo compressors are much less efficient at high than at low compressions, and, indeed, there is a higher limit beyond which the turbo compressor cannot go. This is a most important matter in practical compressor work.

Now let us point out briefly how this diagram can be used without modification for ordinary gas engine work. The ordinary gas engine card is of the shape B F G H in Fig. 1. Construct a work diagram in which—there being no appreciable waste of kinetic energy—the theoretical and actual expansion lines are the same. The actual work done is represented by the area B F G H. Then we know that (Fig. 1)

B F G H = A B F E + E F G D − K H G D − A B H K.

Now all the areas on the right-hand side of the above equation can be read off directly from the diagram, so that we immediately obtain the work done. The heat added, whether by combustion or from an external source, is determined in the manner previously indicated, so that we readily determine the efficiency. The lines on the work diagram give us, of course, the condition of the gas at all points. The areas A B F E and K H G D are read off on the horizontal scale W, whilst the other two are read from the vertical scale of I.

As mentioned at the beginning of this article, we may use what is, in some respects, a new diagram for gas engine and general reciprocator problems. From Fig. 1 we see that the net work done is the algebraic sum of the works of compression and expansion; that is

B F G H = M B F N − M H G N.

Now the area M B F N is equal to

$$W = \frac{p_1\,u_1 - p_2\,u_2}{n - 1}$$
$$= \frac{p_1\,u_1^n\,(u_1^{1-n} - u_2^{1-n})}{n - 1}$$
$$= \frac{R\,(T_1 - T_2)}{n - 1}$$

We can then construct a work diagram along the same general lines as that already described, with the difference that now the values of W represent the actual works done in given expansions or compressions. We first draw in a series of constant *volume* lines passing through the origin of absolute temperature, after the manner adopted to draw in the constant *pressure* lines of the former work diagram. The rest of the diagram differs little from the former. In this case we see that the work done in a gas engine, hot air engine, or compressed air motor, can be read off directly from the diagram with somewhat less trouble than if the former diagram were used. We must, of course, choose some standard volume u_2. This can usually be best decided according to the nature of the class of work for which the diagram is intended. The volume of one pound of air at atmospheric pressure and temperature is a convenient standard for many purposes. Where there is difficulty in deciding on a suitable standard the work diagram previously described can be resorted to, as in that diagram the maximum volume does not cut any figure. Usually, however, there will be no trouble in constructing a suitable diagram.

It is important to remember that the quantity W used in our diagram represents an area on the pressure volume card, and that this area is not always an actual quantity of work done by the gas or on the gas. The great value of the diagram is due to the fact that, once constructed, it almost does away with the necessity for further calculation in solving gas engine and gas turbine problems.

PROGRESS WITH PNEUMATIC TOOLS.

WHILE only the other day complaints were received on the part of artisans in the Royal Dockyards regarding the harmful effect of being compelled to handle the pneumatic tools now largely in use for caulking and chipping and riveting in ship work—complaints which were discredited entirely by the medical officer appealed to by the dockyard authorities—it is of interest to learn that no such objections to the use of these labour-saving appliances are urged by the workmen in private yards. On the contrary, it is significant that an agreement has been come to between the Federated Shipbuilding and Engineering Employers, both in Scotland and England, and the Workmen's Society, not only to encourage the members to avail themselves of the tools which the employers have, at great cost, provided, but to allow a very substantial reduction on the rates of pay for work done by their aid. On and after to-day, and for a period of at least six months, the workmen handling these tools will do so at a reduced scale of pay for work done of 40 per cent. on shell plating and 35 per cent. on interior work generally. This arrangement will be introduced into yards where these tools have for a number of years been looked upon with anything but favour by the great bulk of the workmen. The fact of such a substantial reduction in workmen's rates being allowed by the Workmen's Society officials is eloquent testimony to their labour-saving qualities. The work is not only done more rapidly, but is of a higher quality than hand work, although in the matter of riveting, perhaps, there is still something left to be desired. In America, on the other hand, riveting is as largely done by these tools as is in the case of chipping, caulking, and drilling. In a paper read on the 24th ult. before the North-East Coast Institution of Engineers and Shipbuilders, at Newcastle, by Mr. Charles Schofield, cabled assurances were read from a number of United States firms, giving the extent to which these tools were employed, even for riveting of ships. The statements created something of a sensation amongst the assembled employers of the North-East Coast and their managers. In reply to the request: "Will you be so good as to cable me the approximate percentage of the entire number of rivets in the shell of a ship which you are now driving with pneumatic tools?" the author received a cablegram from the American Shipbuilding Company: "Eighty-five to ninety per cent.;" from the Newport News Shipbuilding Company: "Thirty in shell, eighty in hull;" from Cramp's Yard, of Philadelphia, where Mr. Schofield was manager for seven or eight years: "Ninety-nine;" and from the Maryland Shipbuilding and Steel Company, Sparrows Point: "One hundred." Thus every rivet is closed, in some cases, by pneumatic appliances; and, further, food for reflection is provided by the fact that this is accomplished by what in this country is termed "unskilled labour," the tools being operated by men or youths who have served no apprenticeship in riveting.

THE PORT OF LONDON.

WE recently called attention to a report on the Ports of London and Antwerp issued by the Thames Conservancy. Since then the Rivers Committee of the London County Council have presented a report to the Council on the "Administration of the Port of London," in which they express the opinion that London is placed at a great disadvantage owing to the failure of the Government "to secure reforms in the administration of the Port of London and the improvements in its accommodation which are urgently required." Attention is called to the report of the Royal Commission of 1902, which recommended the creation of a public authority for the administration of the port and docks in place of the numerous authorities which now have divided jurisdiction, and in which it was suggested that the London County Council should contribute two and a-half millions towards the amount required for deepening the channel, and should guarantee the interest on the money required to be raised for the purchase of the docks.

The grounds on which the London County Council claim that there is urgent necessity for reform are:—The delay in the delivery of goods from the docks; the injury suffered in consequence by the trade of London; that the dock companies have not been able for financial reasons to "adapt their respective powers fully to meet the change of circumstances that has occurred in the size of the ships now in use for the distribution of the enormous cargoes carried;" the inadequacy of the existing quays and berths for the accommodation of ships, and also of the entrance locks and depth of water in the docks to meet the requirements of modern vessels; also of the inadequacy of sorting sheds and of storage room for refrigerated produce; the want of access for barges to the vessels, and the consequent congestion at the docks; the insufficiency of graving docks, dock plant, cranes, &c. It is urged that while certain continental ports are gaining in favour, there is "dissatisfaction with the Port of London, for one reason or another, on the part of all concerned, whether as shipowners or merchants," and that in the opinion of the Rivers Committee "it has been proved that the Port of London is in danger of losing a part of its existing trade, which might otherwise come to it, by reason of the river channel and docks being inadequate to meet the increased and increasing requirements of modern commerce." The Committee wind up their report by saying that they consider that the sum of seven millions is required to bring the channel and docks up to date. Attention is drawn to the fact that Bills were introduced into Parliament by the Government in 1903 and 1904 dealing with this subject, and also by the County Council, which, however, for one reason or another, failed to obtain legislative sanction. Attention is also directed to what is being done at Antwerp and other continental ports, but, as we have recently dealt with this part of the subject in noticing the report of the Conservancy, it is not necessary to repeat what has been said. The report also refers to the large sums being spent by Liverpool, Bristol, Southampton, &c., in modernising their dock systems.

It is shown that the dividends paid by the existing dock companies do not warrant any further large outlay by them on improvements, the dividend on the London and India Companies on their preferred stock having fallen from 4 per cent., which was paid in 1902, to 3¾ per cent in 1903 and 1904, although to meet increased charges the dues on shipping were raised from 1s. to 1s. 6d. per ton. The Millwall Company is not able to pay any dividend on the ordinary or preferred stocks. The Committee consider that the dredging and deepening of the river about to be carried out by the Conservancy under the powers of the Act obtained in the last session "may result in greater congestion at or near the entrance to the docks," unless other works of improvement of the river and dock are also carried out, and intimate that the increased charges on shipping to meet the cost of this dredging may have an injurious effect upon the volume of shipping entering the port.

Although the report does not indicate the source from which the revenue is to be obtained to meet the interest on the seven millions that the Committee state is required to bring the port up to date, and for any loss of income that may ensue from the purchase of the docks, and deprecates any increased dues on shipping, it is obvious that if the London County Council became the guarantors of the interest on the capital expended, any loss between revenue and expenditure could only come out of the rates of London. As an answer to this report, it has been pointed out on behalf of the dock companies, with regard to the statement that these companies are in no better position now to meet the requirements of the situation than they were when the Royal Commission issued its report, that the Surrey Commercial Dock has in many ways been remodelled, a new lock and entrance has been made of ample size to meet all the requirements of the particular trades carried on at that dock; that the accommodation at Tilbury Docks is ample and sufficient for all large vessels, and that vessels rarely, if ever, have to wait for a berth at any of the docks; that the sums being spent at other ports are rendered necessary by the conditions which exist at those ports and which do not prevail in the Thames, which has natural advantages which other ports do not possess. [Thus, for example, at Bristol the channel is practically dry at low water, while in the Thames there is a low-water depth of from 25ft. to 30ft., and the works there will involve a rate in aid from Bristol of 2s. in the pound]; that Tilbury Docks anticipated the character of the works now being carried out at Liverpool to bring their old-fashioned docks up to date; that with the exception of graving dock accommodation, taking everything into consideration, the facilities of the Port of London are better than at any other port; and it is pointed out that large steamers cannot get up to the docks at Hamburg, except at high water, without lightening part of their cargo; and at Antwerp, there is only a depth in the river at low water of 18ft., against 24ft. in London, which is about to be increased to 30ft., whilst at high water the Thames has 42ft., against 32ft. in the Scheldt.

Although it cannot be denied that it is evident that there is room for improvement in the conditions prevailing in the Thames, the question to be solved is the source from which the funds are to be derived to meet the outlay which the London County Council advocate, for if these works are carried out an increased revenue must be provided. It may be inferred from the remarks in the report of the Rivers Committee that they deprecate any increased charges on the shipping for fear of driving trade away from the port; there remains, then, only the rates of London to fall back on, as is the case at Bristol and Preston. If there is to be a rate in aid, and the Council are to guarantee the interest on the seven millions required for improvement and forty millions for the purchase of the docks and wharves, the Council will expect to have a controlling voice on any new Board that is created. If the management of the steamboats by the River Committee is any guide to what would happen if it had control over the port and docks, the ratepayers of London would not have much cause for rejoicing at the changes from the present system, imperfect as it is.

AMERICAN THRESHING MACHINES AND TRACTION ENGINES.

No. IV.*

ANOTHER firm which has a large trade both in the United States and abroad is that of Gaar, Scott and Company, of Richmond, Indiana. One of the latest

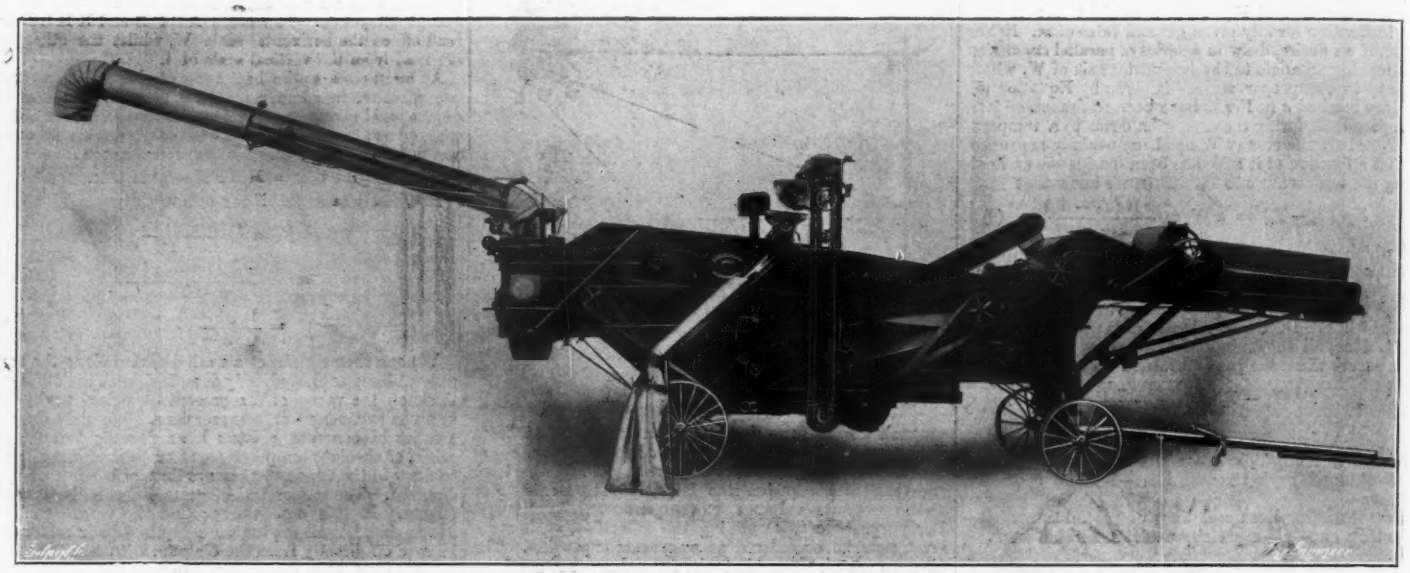


Fig. 17—GAAR-SCOTT THRESHING MACHINE

of its threshing machines is shown in Fig. 17, and a sectional view is given in Fig. 18. This belongs to the shaking sieve type of machines, and may be compared with the Geiser machine of the comb and roller type, which has already been described.

The main threshing cylinder A, with the concave B and grate C are at the front end, with the beater D and the straw racks E and F behind. The sheet iron apron G checks the flying grain from the beater, and also holds the straw down upon the racks. The cylinder has sixteen bars, and is mounted on a 2¼in. shaft, with driving pulley 10½in. or 12in. diameter. A large cylinder is used in order to increase the threshing effect with a lower speed of the cylinder, and also to get a greater separation at the cylinder. The speed with a 30in. to 36in. cylinder—measured over the teeth—is 900 revolutions per minute, as compared with 1200 revolutions for the smaller cylinders. With this construction, the large cylinder knocks practically all the grain out of the heads, and about 90 per cent. of it is separated from the straw on the long stretch of grates before reaching the straw

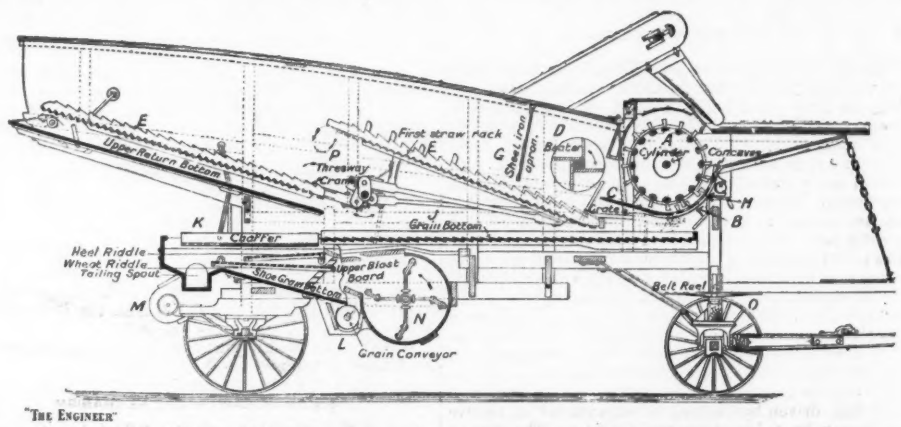


Fig. 18—SECTION OF THRESHING MAC INE

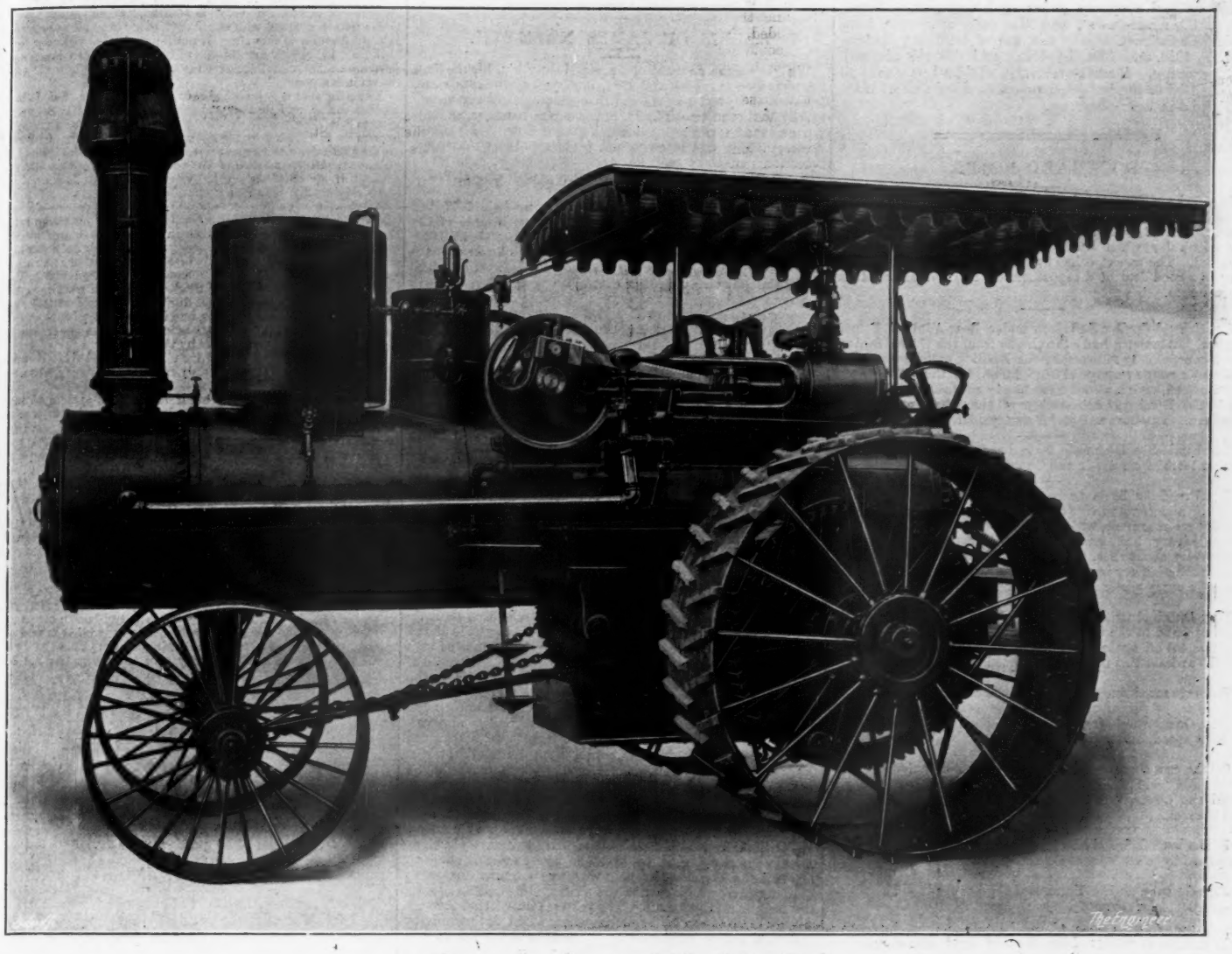
racks. The concave and grate have iron sides, and can be raised and lowered so as to adjust the width of throat opening to the kind or condition of seed or grain which is being handled. Between the upper and lower sections of the concave is an intermediate grate H, and through this the grain that has been threshed out by the upper concave drops at once to the grain bottom J. Thus it is not carried to the lower concave, where it is likely to be cracked and broken, and to interfere with the clean threshing of the remaining grain.

The revolving beater D checks the flying grain as it comes from the cylinder, and diverts it downward, while at the same time it drives the straw on to the straw racks, spreading it out in a thin sheet to facilitate the action of the racks in completing the work of separation. The beater has four wings or blades, covered with sheet iron, and the straw passes under both the cylinder and the beater. The conveyor pan, or grain bottom J, carries

* No. III. appeared November 24th.

TRACTION ENGINE

GAAR, SCOTT AND CO., RICHMOND, INDIANA, ENGINEERS



the grain at once to the chaffing riddle K, having its bars set at an angle. The grain passing through this falls upon two more riddles, and thence into the shoe or hopper, which delivers it to the grain conveyor L. The tailings from the ends of the chaffer and the wheat riddle fall into the spout of the tailings conveyor M. The chaffer has a longitudinal shaking motion, and the shoe and riddles have a lateral motion to prevent the grain moving endways to the tailings conveyor. The separation at the chaffer and riddles is aided by a blast of air from the fan or paddle blower N. When the machine is not in use, the main belts are wound round a vertical pin set in an iron disc O, which supports the roll of belting.

The straw or separating racks are operated from a three-way crank shaft, shown at P in Fig. 18, the direction of motion is indicated by the arrows, which gives to the straw a lifting and jarring action. Fig. 19 shows this mechanism in further detail. The crank shaft A has the three cranks B, B, B, placed at 120 degrees. Two of these are connected to the two straw racks C, C, while the third one has a pitman D, which works the grain bottom. The throw of the cranks is 5½in., giving an 11in. stroke to racks, and the straw has a fall of 15in. from the top of the first rack to the bottom of the second. The bars of the racks are widely spaced, so as not to waste any grain in the straw even when working at high speed, and in operation there is very little grain left in the straw which has passed the first rack.

The wind or blast stacker has a three-bladed steel centrifugal fan, driven by enclosed bevel gears, which receive their power by a belt from the cylinder. The flue or shoot is of galvanised iron, made telescopic, and fitted with an adjustable hood. The operator of the machine can regulate the length of the shoot and the position of the hood at any time, while an automatic oscillating device at the heel traverses the shoot to and fro in the arc of a circle. All these means assist in the building up of a good straw stack with little hand labour. The chaff may be kept separate from the straw, which is important when the straw is to be baled or made saleable for the manufacture of paper or strawboard.

The self-feeding apparatus has a carrier of cotton duck, and the band cutter is hung on two iron arms, which are adjustable so as to adapt the cutters to large or small sheaves. The steel knives are segmental, or crescent-shaped, set 4½in. apart and at different parts of the circumference of a shaft. The shaft is surrounded by a sleeve or drum, leaving 8½in. of the knives exposed. Guards between the knives prevent wet or matted straw from wrapping around the shaft or drum. An important part of the feeder is the governor and distributor, which is a shaft fitted with spiral curved teeth and placed close to and above the threshing cylinder. This makes only about 25 revolutions per minute, separates and spreads the straw, and prevents it from going to the cylinder in bunches. The cutter knives and the distributor teeth effectually spread the straw, and as it enters the cylinder the upper part is retarded by the slow movement of the distributor, while the under part is seized by the swiftly revolving teeth of the cylinder. Thus the feed is more even and regular than by hand.

A speed governor for the feeding apparatus is attached to the driving pulley of the beater, and consists of weighted levers moved by centrifugal force. When the

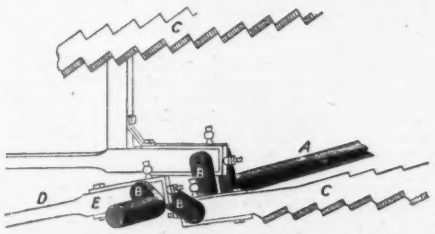


Fig. 19—STRAW RACK MECHANISM

speed of the threshing cylinder falls below the proper threshing speed, the governor stops the carrier of the self-feeder, and thus prevents the overloading of the machine. A weighing apparatus, with register, is fitted in connection with a bagging device or a wagon loading spout. The bagging device has a counter to show the number of bags filled.

The regular threshers, with wind stacker attached, weigh from 8300 lb., with 33in. cylinder 52in. long, to 8940 lb., with cylinder 36in. by 56in., and 9345 lb., with cylinder 40in. by 64in. Special modifications of these machines are made for threshing rice, hulling clover, and similar work. The several machines are in use in Russia, Egypt, and other countries, as well as in Canada Mexico, and the United States.

The Gaar-Scott Company's traction engine is shown above. The fire-box is of the locomotive tubular type, with 2in. cold drawn seamless steel tubes, fitted with copper ferrules in the ½in. tube sheet, over which the ends of the tubes are beaded. The fire-box has an arched crown sheet, and a round water bottom forming a continuation of the side water spaces. There is an ashdoor below the fire door, In the straw-burning boiler, however, there is the usual open grate with ashpan beneath, but this is built of boiler plates instead of the usual sheet iron. No foundation ring is used, the inside fire-box plates being curved and flanged outward at the bottom, and riveted to the outer plates. A very large fire hole is used, with the plates riveted to a heavy ring. It has two doors, the straw-feed hopper being fitted to the lower opening, and the upper one being available when the tubes are to be cleaned. There is a fire-brick arch extending upward and backward from the lower part of the tube sheet, and in one side of the fire-box is a cleaning door. A draught door is placed at each end of the ashpan. This boiler may be adapted for coal fuel by changing the grates. A special design of straw-burning boiler has return tubes from the smoke-box to an uptake over the fire-door, to which the chimney or funnel is attached.

The dimensions and particulars of the Gaar-Scott Company's 25 horse-power simple traction engine are as follows :—

Rated horse-power	25 horse-power
Brake horse-power	60 horse-power
Cylinder	9½in. by 11in.
Valve	Slide
Front wheels, diameter	3ft. 8in.
,, ,, width	11in.
Driving wheels, diameter	5ft. 6in.
,, ,, width	2ft.
Distance between axles	9ft. 6in.
Boiler, diameter	3ft. 0½in.
Fire-box, length	4ft.
,, width	2ft. 7in.
,, depth	3ft. 2in.
Tubes, number	56
,, diameter	2in.
,, length	8ft. 2in.
Heating surface	298 square feet
Grate area	10·3 ,,
Steam pressure	110 to 150 lb.
Weight of engine	20,775 lb. with ordinary gearing 22,432 lb. with heavy gearing
Length over all	14ft. 3in.
Speed on the road	2-57 miles
Revolutions of crank shaft per minute for full speed of engine	257
Capacity of water tank	90 gallons
Fly-wheel, diameter	3ft. 6in.
,, width	1ft.
Weight of threshing machines hauled	8300 to 9345 lb.

The engine is placed on one side at the top of the boiler, with the cylinder directly over the driving axle, and

driving forward to a crank disc on the engine shaft. Link-motion reversing gear is used, with a slide valve. For heavy work, such as steam ploughing and driving the largest threshing machines, where the engine is apt to be worked to its full capacity, there is a demand for compound engines, as they can be run with greater efficiency and economy under such conditions. These are of 30 horse-power, and the only difference from ordinary construction is in the use of tandem cylinders, 8½in. by 11in. and 13in. by 11in., and the use of extra heavy gearing. A cross-over valve enables live steam to be admitted to the low-pressure cylinder for a short time, if required in heavy hauling.

DOCKYARD NOTES.

THE Duke of Edinburgh, cruiser, on her eight-hour full-speed trials reached a maximum of 22·7 knots. Her designed speed was 22·33, but, somewhat unwisely it was stated by the Admiralty when she was ordered that 24 knots was expected. The expected has by no means come to pass, and there is a good deal of disappointment in service circles in consequence.

THE Second Cruiser Squadron under Rear-Admiral Prince Louis of Battenburg had a race home from the United States. The Drake, closely followed by the Berwick and Cumberland, made an average passage of 18·6 knots for the 3670 miles. The Bedford, which at one time nearly succeeded in beating the Drake, developed hot bearings off the Azores, and left the squadron. The Cornwall and Essex got left astern.

THE battleship Albemarle is to be re-commissioned for a further term of service in the Channel Fleet.

THE Dreadnought is to be launched by her Majesty the Queen. According to a New York journal, this ship is to carry 11,000 tons of armour, which will leave her with only 7000 tons for machinery, hull, guns, coal, and stores! The American revelations about her, upon this calculation, seem hardly trustworthy. They are, as a matter of fact, just about as wrong in every particular as they could possibly be.

THE Dutch battleship Hertog Hendrik, which recently went aground in the Celebes, has been successfully refloated. She was got off again by firing her after turret and using the recoil—at least this is gravely asserted by the Dutch Press.

THE armoured cruiser Warrior has been launched.

THE Orion class of cruisers will, it is rumoured, be of 25 knot speed, and carry 12in. guns.

OF the new "ocean-going" destroyers of 33 knots, Elswick will build two, the Ghurka and Afridi. Thornycroft will build the Tartar, White's the Mohawk, and Laird Brothers the Cossack.

IT has been definitely decided that the new German battleships are to be of 18,000 tons and the cruisers of 15,000 tons.

THE German cruiser Yorck is doing her trials. The Roon is completed for sea.

THE German cruiser of the Bremen type, hitherto known as Ersatz München, has been named Königsberg.

COLOURED funnels are the latest German naval fancy. All ships will have rings to denote them as follows:—Kaiser class, white; Wittelsbach class, black; Braunschweig class, red; Brandenburg class, yellow.

THE United States battleship Mississippi has been launched.

THE Dutch battleship Tromp has made 16·83 knots on her trial trip at full power.

RAILWAY COAL CONTRACTS.

IT is many years since the placing of the contracts for the following year's supplies of locomotive coal for the various railway companies created such interest as at the present time. The active state of the steam coal trade has enabled coalowners to demand an advance of 6d. per ton on steam coal for shipment over next year, and this action has paved the way for sending in tenders for railway supplies at advanced rates. During the present week the whole of the tenders for supplies of locomotive coal have been sent in. It now appears that the South Yorkshire owners, by previous arrangement, have tendered for supplies for the first half of next year at 8s. 6d. per ton, but anticipating that trade will advance, they have quoted 9s. per ton for the second half of the year. It has also leaked out that some of the companies have made a counter offer of 8s. 3d. per ton. What course will be adopted remains to be seen, but it is predicted by some of the best authorities that the price is likely to be 8s. 9d. per ton over the year. The statement that the North-Eastern Railway Company had placed their contracts with Durham, Northumberland, and South Yorkshire collieries, at an advance of 6d. per ton, lacks confirmation. On the one hand, shippers carrying on business at Hull are objecting to pay an advance of 6d. per ton on next year's supplies for shipment sent from South Yorkshire, because they are unable to do business abroad, the prices demanded being so much in excess of that for best Northumberland steam coal. On the other hand, it is improbable that such an offer should have been made to South Yorkshire coalowners before most of the tenders had been sent out to other companies. All kinds of devices have been resorted to in years past to bring down the quoted rates, and as the tenders are out sooner than usual, it is more than probable that the coalowners will act as a body and make a stated offer. Inquiries, however, show that if the South Yorkshire steam coalowners remain united, they will get the advance. It is known that the stocks of steam coal at the pits are much less than they were at this period last year, and that some of the firms are already well contracted for next year's output. The output of the thick seam steam coal collieries was never so great as at the present time. Such new collieries as Grimethorpe are making full time, and although in course of development, they are now averaging 2700 tons per working day. The demand for South Yorkshire hards is very active, and notwithstanding the new collieries in the district beyond Rotherham and Doncaster which produce a capital quality of steam coal, the demand is only about equal to the supply.

RELICS OF JAMES NASMYTH.

WE gave some account of James Nasmyth's, life in THE ENGINEER on May 16th and 29rd, 1890, just after his decease, from which it will be gathered that although associated primarily with the introduction of the steam hammer, the improvement of machine tools was a great feature of his useful career, and it will interest our readers to know that some interesting machine tools, formerly his property, have lately been placed on view in the Southern Galleries at South Kensington Museum.

One of the objects is a planing machine, made in 1857, but in arrangement and detail almost identical with some of the larger machines built by Nasmyth and Gaskell about 1840. At that time such machines were generally rack-moved, with quick-return motions, but for sizes up to 3½in. wide by 8in. travel the gear shown in this example was considered to give a quieter and quicker action. The frame is a somewhat massive casting, with two V guides having the apex upwards, so that, though not retaining the oil so readily as the later shape, they did not form receptacles for dirt. The two standards are bolted to the main framing and connected by a cross girder which carries a central screw by which the height of the cross slide is adjusted; the latter has an internal traversing screw for moving the tool rest, which is capable of angular adjustment and has a hand-feed motion. The tool-holder has the usual hinged box for preventing damage to the tool on the return stroke.

The table of the machine is a single casting, with slides planed on its lower surface corresponding with the fixed guides; the upper part has six longitudinal T-headed grooves for receiving the bolts which secure the work. The table is moved to and fro by a mangle-wheel motion, two chains passing from the lower side of the table over fixed guide pulleys down to a chain wheel, round which they pass in opposite directions before being secured; the shaft of this wheel carries at one extremity a wheel with lantern pins or teeth, into which a small pinion on the driving shaft gears. The pinion end of this shaft is carried in a sliding bearing, so that the pinion gears alternately inside and outside of the segmental lantern wheel, thus reversing the motion after a definite length of travel has been effected. The length of stroke can be permanently altered by removing from the mangle wheel some of its teeth, which are single pins secured by nuts. In the machine shown a hand-driving mechanism has been added, and the loose pulley removed. The transverse travel of the tool-box is automatically given by a pawl feed, receiving its motion from the lateral play of the pinion shaft.

The machine above described is of considerable size, and stands alone in the gallery. Near it in a glass case are a drilling machine and a shaper, which both belonged at one time to Mr. Nasmyth. They are beautiful specimens of workmanship. The driller is much like those constructed about sixty years ago. spindle overhanging, in the manner now generally adopted. The framing consists of a base with two columns supporting a cross-girder, which carries the drill spindle and its driving and feeding arrangements. The power is transferred through mitre wheels to the drill spindle, which is fed downwards by a central screw supported by a cross-head carried on two small wrought iron columns. This screw is fitted with a winch-handle for feeding it downwards by hand; there is also an automatic feed given by a vertical shaft that is intermittently rotated by a pawl worked by an excentric on the lower end of the spindle sleeve. In the larger machines of this kind step driving pulleys were used in connection with an independent work-table having horizontal screw adjustment in two directions.

The shaper is an early form of hand-worked machine, the driving shaft terminating in a disc in which is a slot carrying an adjustable crank pin, by which the length of stroke can be varied. This pin is fitted with a block capable of sliding in a vertical slot formed on a horizontal ram, that carries the tool-box; the ram works in adjustable V guides, and is fitted with a vertical slide in which the tool-box is fed by hand. The work-table slides on guides on the front of the main casting, and is traversed by an internal screw driven by hand power, or automatically, by a pawl feed motion rocked by an excentric on the main shaft. The table is fitted with a vice, and there is also an arrangement for holding square and hexagonal nuts while being shaped. The machine has a heavy hand wheel of brass, and is fixed on a wooden stand about 18in square.

Just before these are reached—coming in from Exhibition-road—is a curious old copperplate printing press, once owned by James Nasmyth. The date and the maker's name are alike wanting. It has two adjustable housings of cast iron, carrying a 6in. diameter roll below and a 2in. roll above. Between the rolls is a travelling wooden table, faced with iron plate, which rests on the lower roll, and also upon four loose supporting and guiding rollers. The inked and cleaned plate being placed on the table, and covered with a damped sheet of paper, upon which is placed some blanketing, the whole is then passed between the rolls, while the upper roll is being turned by a long double-ended hand lever. This lever is now of wood, and not able to bear, apparently, very much strain, but possibly the original was stouter, or made of metal. The arrangement gives a powerful squeeze without subjecting either plate or table to any bending stress. The general construction of the press is not very different from that of a modern hand press of equal size, whilst the roller arrangement is one of great antiquity. None of these relics are yet in the official catalogue, for though acquired by the Museum in 1899, it has only lately become possible to exhibit them to the public.

MANCHESTER ENGINEERS' ASSOCIATION.—"The Results of Technical Education in Engineering" was the title of a paper read at the meeting of the above Association on Saturday, by Professor Goodman, M. Inst. C.E, the University, Leeds. There was a large audience. Mr. R. Matthews, president, occupied the chair, and dealing as the lecturer did with the subject from a modern and technical standpoint, it aroused deep interest. The discussion which followed was interesting, and before it was concluded Professor Goodman, having to leave to catch his train, was accorded a hearty vote of thanks. The visit to the new Cunarder Carmania has been postponed until the return of the vessel after her first voyage.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

AIR IN CONDENSERS.

SIR,—I beg leave to refer to the paragraph in the article on s.s. Carmania, in your last issue, which states:—"The condensers are fitted with double-cylinder 'dry' air pumps to get the last fraction of vacuum. How air gets in it is not easy to say, because the shafts are fitted with steam lantern brasses, the pressure on which is 2 lb. over the atmosphere, so how air can be drawn in is a puzzle."

Assuming that it is practicable to prevent ingress of air into the turbine casing, and that air leakages directly into the condensing system are preventable, it may be assumed that any air in the system is introduced by means of or along with the feed water passing into the steam generators, hence naturally the type of feed apparatus and the method of its working may largely control the amount of air which enters the system, and which has eventually to be rejected by the air pump at a later stage.

A case of marine practice where the feed pumps are driven by the main engines, and where an ordinary type of air pump is used, furnishes an example whereby much air may be introduced into the system. The hot-well discharge generally contains water highly aërated; this passes immediately into the feed pumps as a rule, and generally the feed pump displacement volumes are much in excess of the actual volume of water discharged by the air pump, hence excess air enters the feed-pumps during every suction stroke along with the aërated hot-well water, and in an ordinary feed-pump free of air lock this air and water passes into the steam generator, to be extracted from the system later by the air pump.

Even with independently-driven float-controlled feed pumps, the hot-well water, if not already saturated with air, absorbs air under atmospheric influence.

The presence of an excess of air in the feed system of marine reciprocating engines has long been known and rather appreciated, from the point of view that its absence in the feed system would inevitably cause a breakage in the feed pipes when the pumps received an abnormal charge of water, due to rolling or pitching effects at sea.

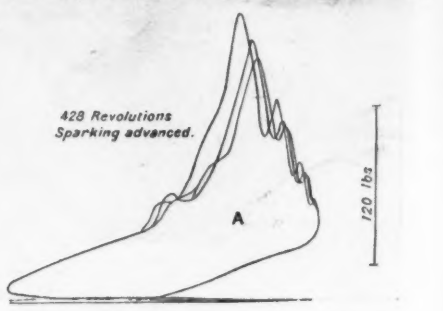
That air may be almost entirely eliminated from a turbine system of plant appears quite probable, and also that a suitable compromise may be arrived at—if any apparent disadvantages accrue from the exclusion of air from the system—by a satisfactory method of providing a cushioned flow of the feed water.

Manchester, November 27th. ANDREW W. JOHNSTON.

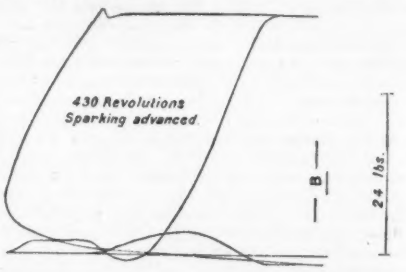
INDICATING PETROL ENGINES.

SIR,—Diagrams A, B, and C have been taken on an ordinary four-cylinder 4½in. by 6in. stroke four-cycle petrol-boat motor engine, with cranks at 180 deg., and mechanically controlled in and outlet valves, the sparking being retarded in diagram C.

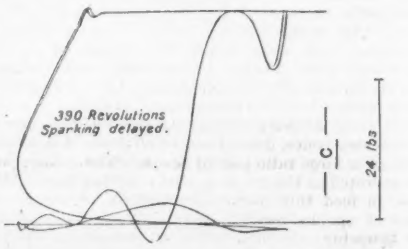
Will any of your readers kindly give the recognised method of



combining the two sets of diagrams for finding the horse-power—what part of the cards is negative work and is to be subtracted?—and also explain what produces the unevenness in the middle of



the expansion stroke, the rise in pressure in the middle of the suction stroke, and the rise and fall in pressure of the compression stroke until the middle of its stroke



Diagrams taken with different power springs all reproduce the same curves in the same spots. The weak spring diagrams show only the low pressures, as after a certain point was reached the spring was compressed to its limit.

November 9th. Δ

FLASH BOILERS.

SIR,—Might I trespass upon your kindness to ask if any of your readers can supply information on the relative efficiency of flash boilers and water-tube boilers? If any work is published on the subject of flash boilers I should be glad to hear of it. I have to consider a proposition involving the use of a large number of small power plants, and would, therefore, be glad to hear experiences.

November 28th. HORSE-POWER.

BORING AND DRILLING MACHINES.

WITH our last issue we gave a sixteen-page special Supplement devoted wholly to drilling and boring machines. It had been impossible to find space in it for all the machines of which we had collected illustrations and descriptions, and to-day we propose to deal with some of the more notable machines omitted from it.

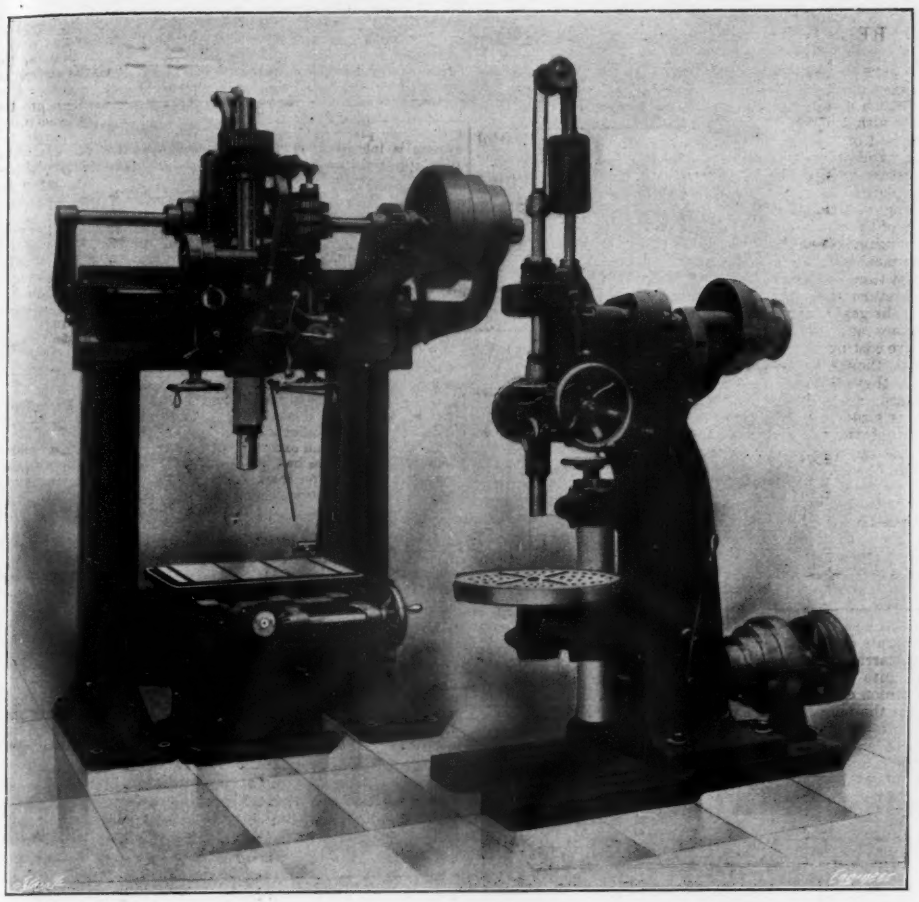


Fig. 1—VERTICAL DRILLING MACHINES—TANGYE TOOL AND ELECTRIC COMPANY, LIMITED

We illustrate first two drilling machines by the Tangye Tool and Electric Company, designed specially for using to advantage twist drills of high-speed steel. The machine illustrated to the left in Fig. 1 is out of the ordinary run, and is to be regarded rather in the light of a testing machine than of an ordinary drill press, since it has been designed, not with the object of drilling holes, but of seeing how much high-speed drills can do. It has been recently constructed by the Tangye Tool and Electric Company, Limited, of Birmingham, for Samuel Osborn and Co., of Sheffield, by whom it is being used to test and demonstrate the abilities of Mushet high-speed twist drills. The main features of the design are obvious. The drill headstock T is mounted on a cross slide, on which it can be moved to and fro. Below the drill is a table, with traversing motion at right angles to that of the headstock. Hence, any part of the table may be reached by the drill, and the range of a radial is secured without the disadvantage of a long overhanging arm.

The spindle is 3in. diameter, of hard steel, and is driven by a horizontal shaft through spur and mitre gear. It is balanced so that it may be run quickly up and down by hand, and the thrust is taken by a ball bearing at the bottom end.

The horizontal shaft is driven by a three-step cone, with diameter 15in., 18in., and 21in., either direct for small drills, or through the double gear shown for larger sizes. The change is effected instantly by a clutch. Using a two-speed countershaft, twelve changes of speed, varying between 76 and 525 revolutions of the spindle per minute is obtained. The feed is driven by a short belt, which affords a very desirable safety-valve in a machine which is to be driven up to its limits. The belt runs on two step cones, driving a nest of three change wheels through a large ratio pair of bevels. The change wheels are operated in the usual way by a sliding key. The six rates of feed thus secured range from 30 to 93 revolutions of spindle per inch travel. A neat arrangement for throwing out the feed instantly, no matter how heavy the cut may be, is provided. The spindle of the driven set of change wheels is broken below its lower bearing, and a universal joint introduced. On the lower part of the shaft is the feed worm gearing, with the worm wheel in the usual way. The worm can, however, be moved to the right—out of gear—and the feed instantly stopped, without touching the friction clutch, which would take longer to release.

The distance between the uprights of this machine is 2ft. 8½in., the maximum distance from the spindle to the table 27in., and the vertical feed 12in. The table is 2ft. 4in. long by 18in. wide.

We have been favoured by Samuel Osborn and Co. with some particulars of tests made with this machine, which will be found interesting. Operating on a Siemens-Martin acid steel billet, holes were made with a 2⅜ drill at the rate of 3·58in. feed per minute, and a speed of 111 revolutions per minute; a 1⅛ drill, at 181 revolutions per minute, drilled at the rate of 5·85in. in the same time; a $\frac{15}{16}$ drill, making 269 revolutions, drilled 6·99in.; and a ¾ drill pierced 9¾in., with 376 revolutions, in one minute. This speed was nearly doubled when the same sized drill was used on cast iron, a ¾ hole being made at the rate of 17·02in. per minute with 526 revolutions.

A second machine by Tangyes, also designed for high-speed work, but not for test purposes, is also illustrated by Fig. 1. It is one of two similar machines made to the order of the London County Council. It is driven by a 14in. pulley, taking a 2½in. belt, run at 250 revolutions per minute. The four-step cone has a maximum and minimum diameter of 15in. and 7½in. The purchase through the bevel wheels alone is 1¾ to 1, and through the back gear it reaches 10 to 1. There are three feeds—60, 100, and 140 per inch of travel—and the change is effected by a sliding key actuated by the vertical lever above the hand wheel. The change wheels are connected with the feed worm by a chain, so that the feed may be positive. The worm can be dropped out of gear suddenly, being supported by a small excentric and link, and is provided with a trip motion for stopping instantly at any pre-arranged travel of the spindle, but the hand feed may be continued after the automatic knock-out has acted, so that extra long holes may be drilled without interfering with the setting of the machine. The trip motion is operated by a stop in a disc at the far side of the machine, which makes less than one revolution for the whole travel of the drill.

The spindle, which is 2in. diameter and has a ball thrust, is overbalanced, so that it shall not drop through when drilling small holes.

The peculiarity about the radial drilling machine by Pollock and Macnab, Limited, of Bredbury, near Manchester—illustrated by Fig 5—is the cross-bracing in the interior of the arm, intended to give it extra strength to resist the bending and twisting stresses produced by high-speed drilling. The arrangement of this bracing is shown more clearly in Fig. 4.

The general nature of the head will be obvious from the engraving. The drilling spindle can be given sixteen different speeds of rotation and six changes of feed through gearing. A dial index to show the depth is fitted, and a knock-out gear for stopping the feed when that depth is reached is provided. The thrust of the spindle is taken on a ball bearing. The feed is effected through a friction coupling, so that the greatest rate of speed possible may be given without fear of accidents. The spindle is placed in the centre of the saddle, so that the load may be distributed equally over the vees. A separate tapping spindle, with the necessary reversing gear, and carrying its own friction tap driver, is provided.

The weight of the column sleeve, with its adjuncts, is taken on a ball bearing, so that the arm may be readily swung. There is no side limit to the swing, and the arm may be carried round the complete circle. The design, too, permits of the arm being brought down quite close to the base.

The drive is through the gear box behind the pillar, a constant speed belt being employed. The gearing throughout is of steel cut from the solid. We illustrate also a 6ft. radial drilling machine by the same makers, which calls for no special description—Fig. 6.

A large vertical boring machine, also by Pollock and Macnab, is shown by Figs. 2 and 3. It has a vertical and a horizontal spindle. The vertical spindle has an adjust-

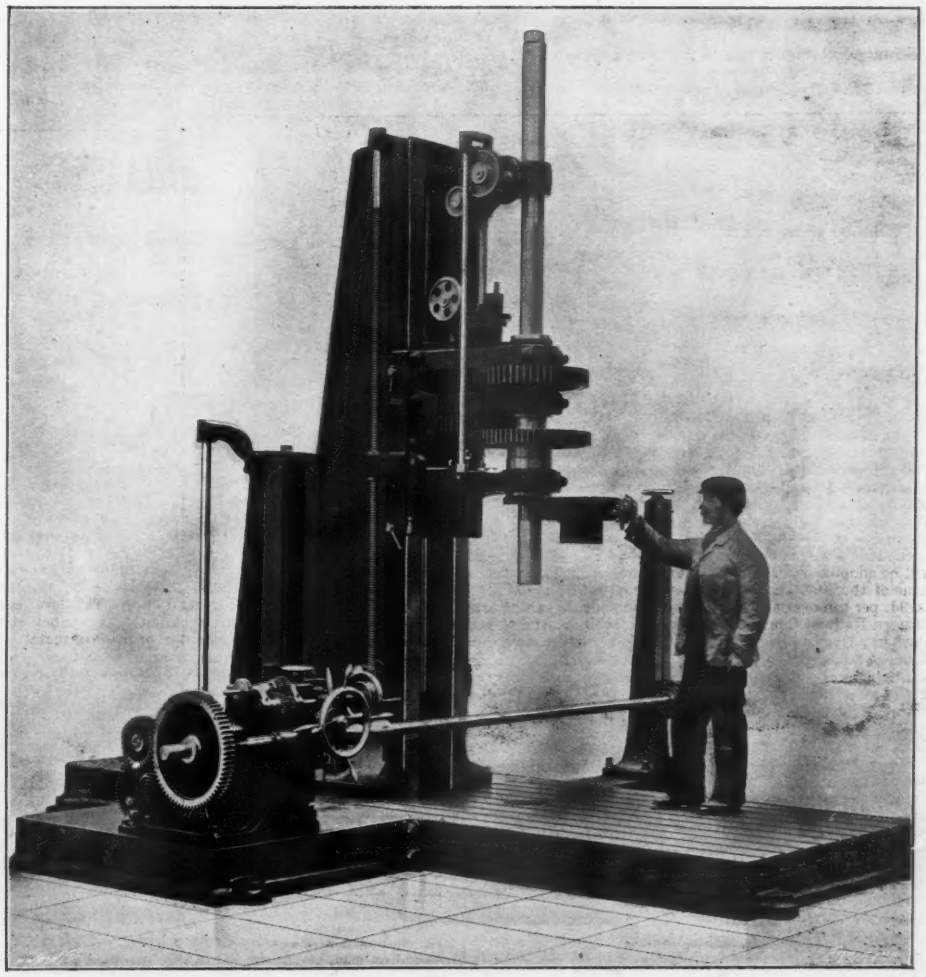


Fig 2—VERTICAL BORING MACHINE—POLLOCK AND MACNAB, LIMITED

ment of 3ft., and is provided with self-acting motion for raising and lowering it; the boring head is also raised and lowered on the slide by power by two screws, one on either side of the upright. Three rates of speed are belt on to the fast and loose pulleys on the end of the bed, the belt being controlled by levers. The spindle slide is balanced, and is fitted with a platform from which the operator can control the various motions, all hand wheels spindle of 5in. diameter, but in other respects it is much like that just described; the outward traverse of the spindle is 8ft., its highest position from the base 11ft., and the lowest position 3ft. from it. The bed is 20ft. long.

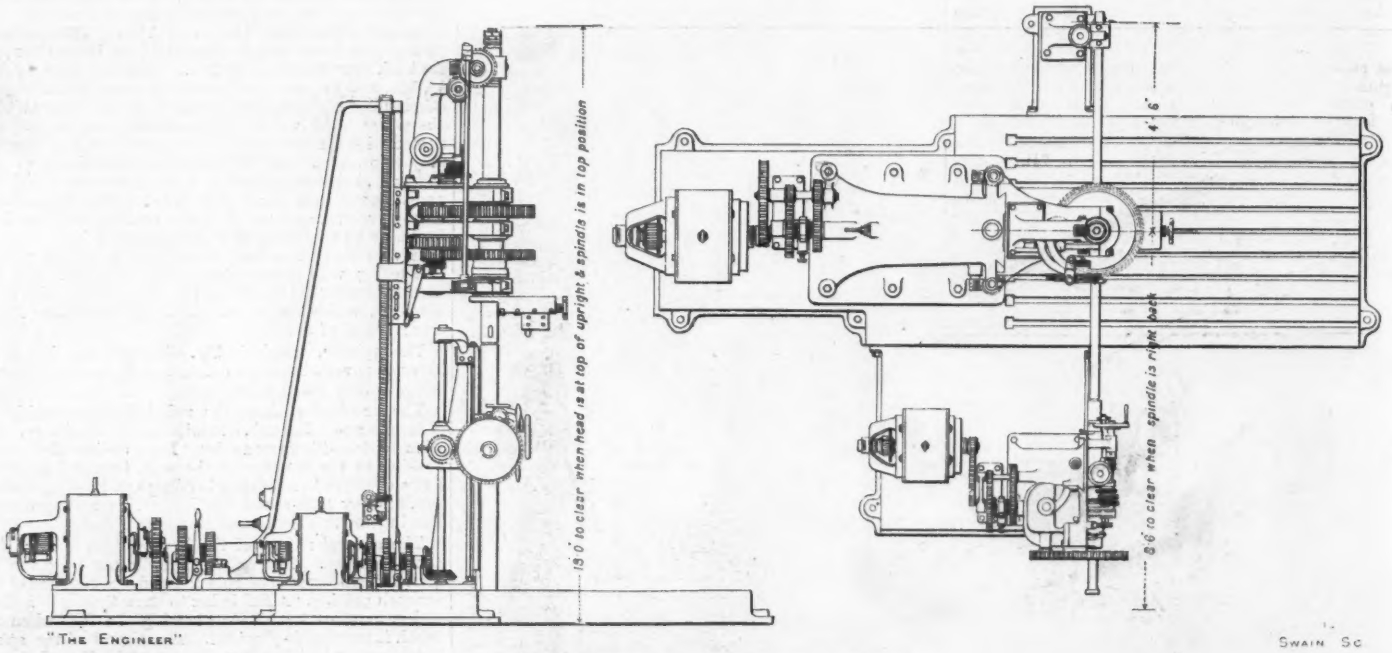

15'0 to clear when head is at top of upright & spindle is in top position
4'6"
8'6 to clear when spindle is right back
"THE ENGINEER"
SWAIN Sc

Fig. 3—DOUBLE BORING MACHINE—POLLOCK AND MACNAB

obtainable, and the correct speed of rotation is arrived at through a gear box and two-speed motor, which do not appear in the engraving, but are seen in the drawing.

The secondary head, which is used for machining crank shaft bearings, will bore holes from 2in. to 6in. diameter. The spindle has three gear changes of feed. The machine has been built specially for boring the water and steam cylinders of steam pumps at one setting. It will bore from 6in. up to 24in., witn two boring heads operating at once, and at ihe same time will face at a maximum height of 7ft. from the base. The horizontal spindle is not used at the same time as the vertical spindle.

Two large horizontal boring, drilling, tapping, and milling machines, by Sir W. G. Armstrong, Whitworth and Co., of Openshaw, Manchester, are shown by Figs. 7 and 8. The second has a 6in. spindle, which may be raised to a height of 12ft. from the base plate, or lowered to within 2ft. 8in. of it. It has an outward feed of 3ft. 6in., and a longitudinal traverse of 16ft. The bed is 22ft. 6in. long, and the base plate 15ft. 6in. by 5ft. wide, provided with facings for the addition of extra pieces if desired. The vertical and horizontal adjustments can be made at a speed of 6ft. 6in. and levers for this purpose being placed within easy reach. Besides the quick run of the spindle up and down the upright, and of the latter along the bed, the machine

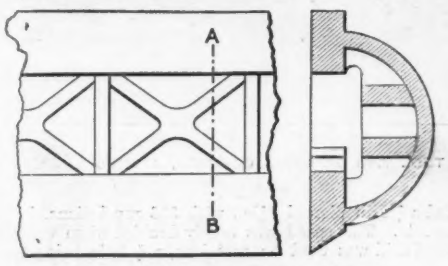


Fig. 4—BRACING OF RADIAL ARM

is fitted with a quick hand motion to the spindle reversing gear for tapping. The spindle speeds are four in number, obtained from four sets of permanent gear, the

The machine is driven by a 12 horse-power motor, variable in speed between 400 and 1200 revolutions per minute.

The portable electrical radial drill, illustrated by Fig. 10, is an interesting special tool. It is intended to be clamped on the turntable of large gun mountings to drill all the holes for fittings that come within its range. It has elongated holes in the base for the clamping bolts. The spindle is 2¼in. diameter, and has a vertical movement of 12in. It can drill at a minimum of 13½in. and a maximum of 48in. from its trunnions. The height from the lower end of the spindle to the base is 20in. A variable speed motor drives the spindle through single and double gear, the former giving speeds from 85 to 260, and the latter from 14 to 40 revolutions per minute. The rates of feed are 75, 95, and 125 per inch. Reversing gear for tapping is fitted.

We illustrate also—Fig. 9—a 7ft. radial drilling machine made by the same firm. The feature of principal interest about it is the drive, the countershaft with the top cone being incorporated in the design. Furthermore, the vertical driving shaft is rotated by a belt instead of by mitre gear, as in the more com-

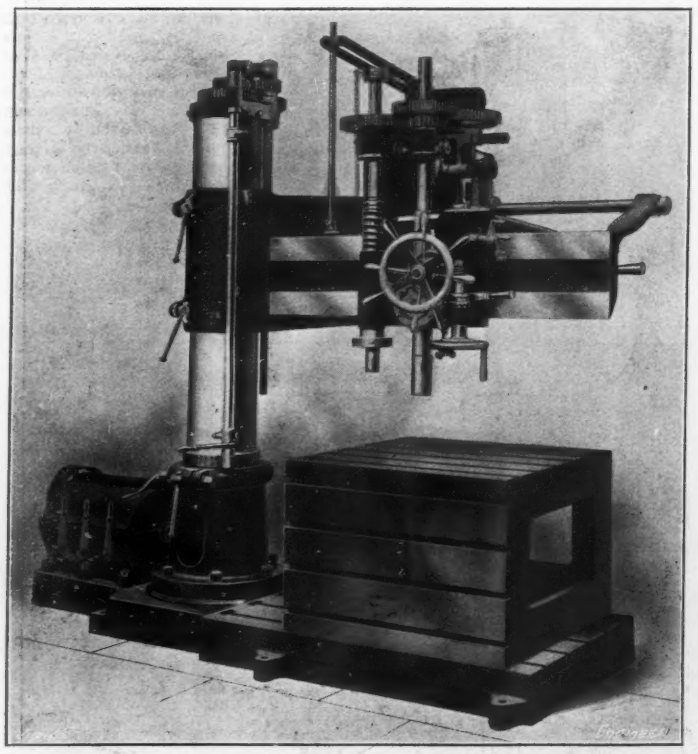


Fig. 5—RADIAL DRILLING AND TAPPING MACHINE—POLLOCK AND MACNAB

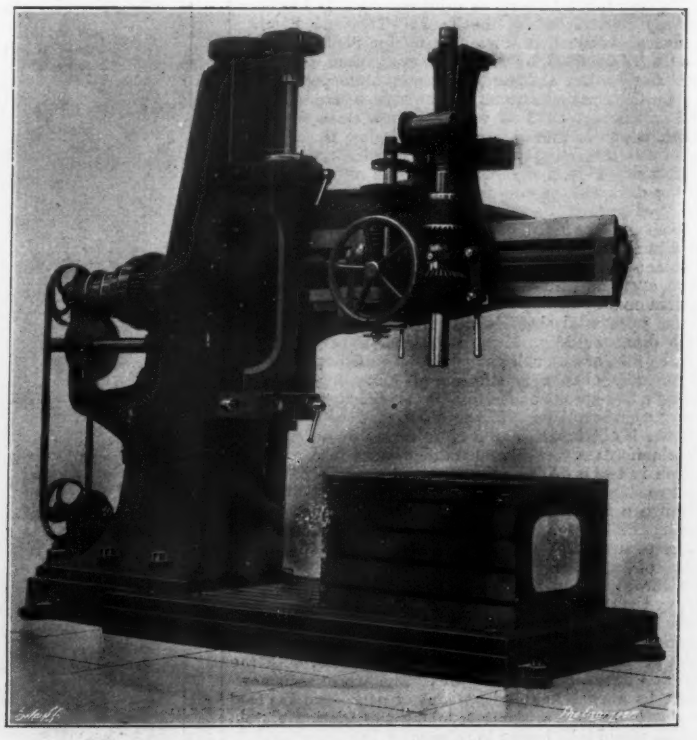


Fig. 6—6-FOOT RADIAL DRILLING MACHINE—POLLOCK AND MACNAB

per minute. This machine is driven from a belt on a countershaft through a cone pulley, and three changes of spur gear on the end of the long bed, and the quick-running gear is actuated by the same countershaft by change being quickly made by a hand wheel, which is marked on the periphery with the number of cuts per inch.

The other machine is slightly smaller, having a mon practice. The chain and chain wheel in front control the belt shifting gear. The left-hand pulley of the three is the driver, the centre pulley is loose; the right-hand narrow pulley drives the clutch mechanism, and

when it is in use the quick reversing gear for elevating and lowering the arm can be used. The spindle of this machine is 3½in. diameter, and it has an 18in. feed. It is balanced, and has quick release and reverse for tapping. All the usual self-acting and change gears are provided.

A four-spindle multiple drilling machine by James Spencer and Co., Hollinwood, Manchester, is shown by Fig. 17, page 542. The machine is, generally, of the planer pattern, and will take work up to 4ft. wide between uprights. The transverse slide is of box section, with planed vees at the front, and is fitted with four drilling headstocks arranged so that four holes up to 1½in. diameter can be drilled simultaneously, the minimum distance between centres being 7½in. The minimum distance between the two outside spindles is 1ft. 10½in., and the maximum 4ft. 3in. The headstocks have a simultaneous traverse on the transverse slide by screw and index wheel. Each head is also capable of being moved along the slide and clamped in any position to drill holes not uniformly spaced, and any headstock can be put in or out of gear without stopping the machine. The headstocks are driven from a four-speed cone pulley through spur and mitre gearing. The drill spindles are of steel 1¾in. diameter, running in cast iron sleeves. Each spindle has hand and variable self-acting feed traverse through a range of 10in. by spur gearing and rack, so arranged that it can be quickly disengaged and allow the spindle to rise freely by counterbalance weight. The maximum distance between the top of the tables and the spindle ends is 1ft. 8in. Each spindle is bored No. 4 Morse taper. The machine has two tables arranged to travel longitudinally, each 6ft. long by 1ft. 9in wide over planed top surface. The traversing gear is shown very clearly in the illustration. The cross shaft is fitted with a disengaging clutch, so that the tables may be moved either simultaneously or independently, and

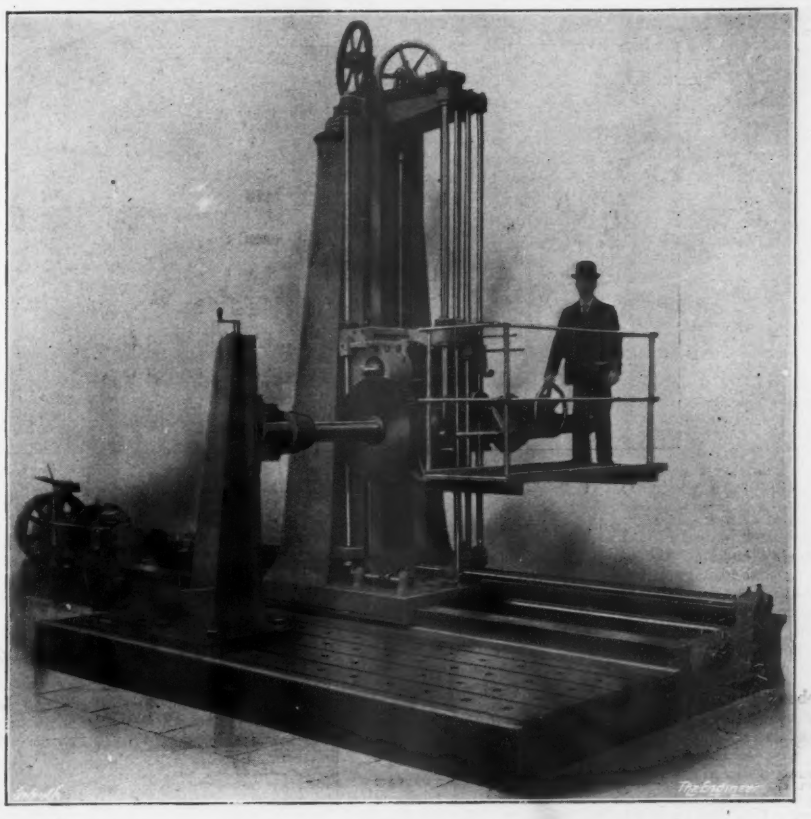


Fig. 8—HORIZONTAL DRILLING AND BORING MACHINE—ARMSTRONG, WHITWORTH AND CO.

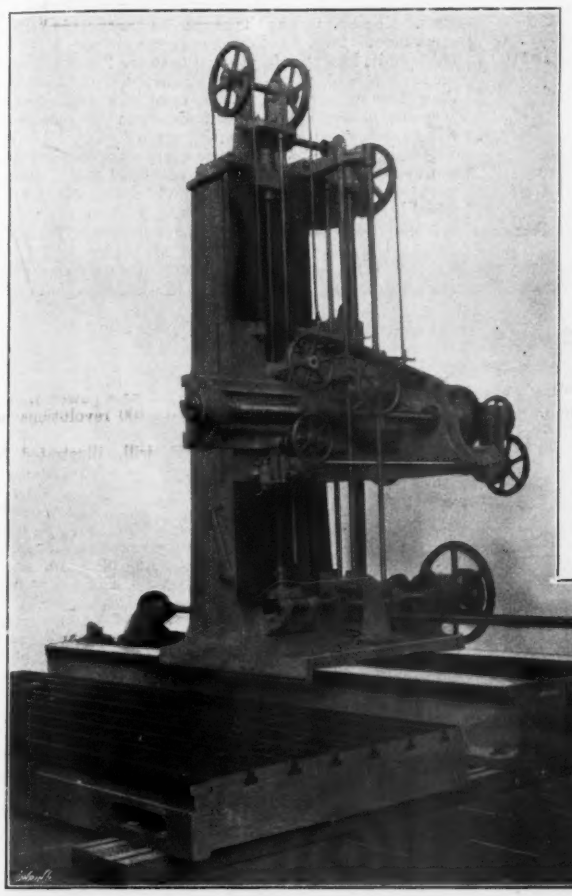


Fig. 7—HORIZONTAL DRILLING AND BORING MACHINE—ARMSTRONG, WHITWORTH AND CO., LIMITED

the end of the cross shaft is provided with disc and handles, and also an index for dividing. Each table runs in vee slide on the outer support; the travel is 6ft. The gearing throughout is machine-cut. The base of the machine forms a tank for lubricant, which is raised to the drills by a rotary pump.

Two double-cylinder boring machines, also by James Spencer and Co., are shown in Figs. 11 and 16. The first is a comparatively small tool capable of boring two cylinders simultaneously, one bar taking from 4in. to 7¾in. diameter cylinders, and the other from 6½in. to 11¾in. diameter. The distance between the bars is adjustable from 7in. to 15in. centres, and both bars will fit either of the spindles. The bed is 8ft. long, mounted on standards, and fitted with a table 3ft. 6in. long by 2ft. 9in. wide. The table has self-acting motion along the bed through a length of 2ft. 6in. The movement is effected by a screw provided with change gearing. Quick hand motion is also fitted. The two steel spindles run in parallel capped gun-metal bearings. They are driven by gun-metal worm wheels running in oil, the worm shafts being coupled by a pair of spur wheels and driven by a three-speed cone pulley. Each spindle is carried by a transverse slide, having independent screw adjustment to vary the centres of spindles from 7in. to 15in. apart. The

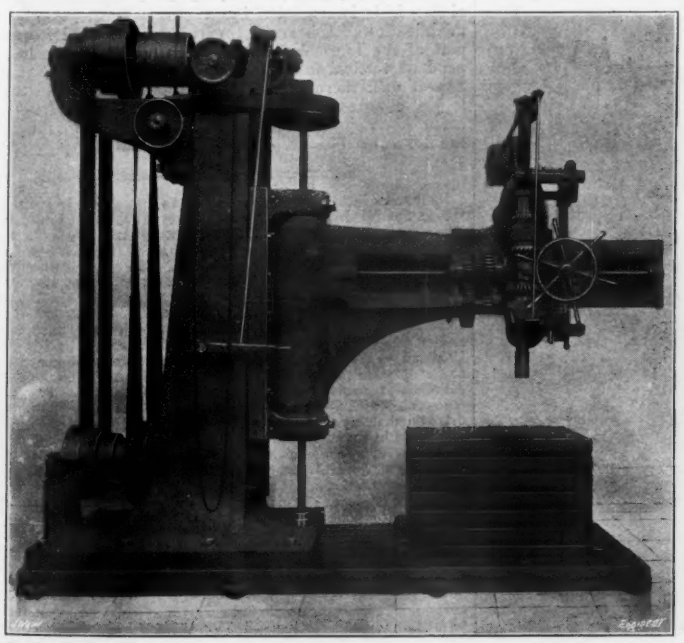


Fig. 9—7-FOOT RADIAL DRILLING MACHINE—ARMSTRONG, WHITWORTH & CO.

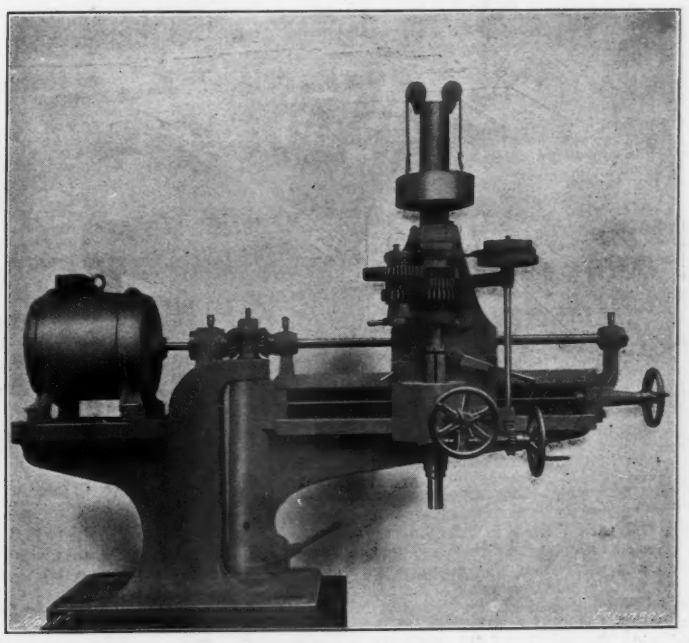


Fig. 10—PORTABLE ELECTRIC RADIAL DRILL—ARMSTRONG, WHITWORTH & CO.

front ends of the spindles are bored up for driving boring bars, &c., and an outer bracket to fix on the table is provided for supporting the outer ends of long bars.

The second double boring machine, Fig. 16, is a larger tool, suitable for boring and facing two locomotive cylinders at the same time up to 19in. diameter by 35in. long. The headstock is fitted with 2¼in. diameter steel spindle, driven by bevel gear from three-speed driving cone placed near one corner of the cross bed. The boring spindle has hand and self-acting motion by screw, and is so arranged that it can be set to any angle to the axis of the cylinders, either above or below the horizontal line.

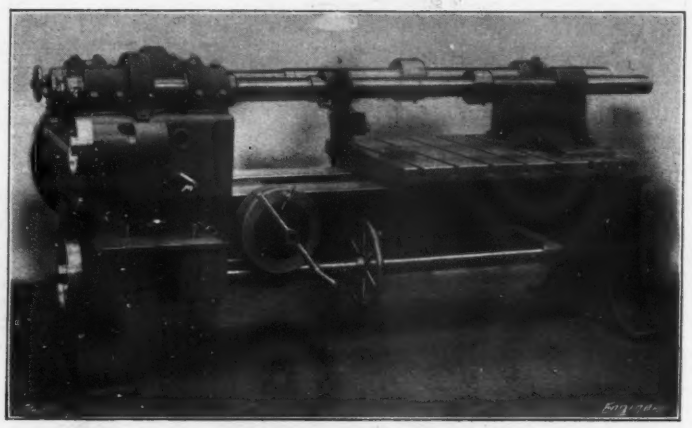


Fig. 11—DOUBLE-CYLINDER BORING MACHINE—JAMES SPENCER AND CO.

The base-plate is 9ft. 6in. long by 5ft. 8in. wide by 9in. deep, planed on the top surface. The two headstocks are fitted with gun-metal capped bearings, and, as in the smaller machine, are driven by worms and wheels, the worms being hardened steel, working in an oil trough, and the wheels of cast iron machine-cut and hobbed to suit the worms. Each headstock is driven independently by belt pulley through spur gearing connected to the worm shaft, and four machine-cut spur wheels are provided to give four changes of speed to each boring bar. Each headstock is fitted with a steel boring bar 7in. diameter on the part where the boring sleeve fits, and reduced at the outer end to 5¼in. diameter. The smaller diameter is fitted with a traversing tool slide to carry a small tool of square steel, with self-acting traverse by screw to clean out the holes through which the small end of the bar passes. Each bar is fitted on the 7in. diameter part with a traversing sleeve traversed by a square-threaded screw recessed into the bar, and having change wheels at the end for giving a continuous feed with three changes, variable from 46 to 24 revolutions per inch of traverse. Each sleeve is fitted with a separate boring head to bore 19in. diameter, and each head is fitted with three adjustable cutters to suit varying diameters of cylinders; the cutters are placed at the front of the boring heads, so as to finish boring close up to a blank end. The heads can be readily changed without removing the sleeve. An outer support or stay is provided for supporting the outer end of each boring bar. One of the driving headstocks is adjustable sideways on the base-plate by screw, so that the distance apart of the boring bars can be varied from 1ft. 8in. to 3ft. centres apart. The corresponding outer support or stay is also adjustable on the cross bed which carries the drilling headstock for valve spindle holes. The height from the top of the baseplate to the centre of the boring bars is 24in. A graduated index is provided for adjusting one of the heads and its outer support to any dimensions between centres within the range of the machine. Two facing heads are provided—one to fit the large diameter of bar, and the other to fit the small diameter of bar—for facing the flanges of cylinders. Each facing head has compound slides to adjust the cut after the heads are set in position on the bar, and each head has a self-acting traverse across the flanges by means of star wheel and trip. At the opposite end to the main driving headstocks a cross bed with V slides is fixed on the base-plate. The V slides carry a column having a balanced saddle working on a vertical slide, with screw adjustment by hand, to set to any height ranging from 24in. to 45in. The vertical slide is adjustable on the cross bed by rack and pinion. The saddle has a drilling and boring spindle for machining the valve spindle stuffing-box holes at the same setting, and whilst the cylinders are being bored. It will machine holes ranging from 1¾in. to 5in. diameter. The gearing throughout is machine-cut.

Three sensitive drilling machines by J. Parkinson and Son are shown in Fig. 15, page 542. The illustration to the right has a single spindle, and possibly the most notable features about it are that it has a sliding and swivelling table and a sliding head. The machine is thus given a very long range for its size, without a great unsupported length of spindle. It has a treadle feed, operated by levers, a quadrant and a chain attached to the hand-feed disc, as well as a lever-feed which can be instantly set to the most convenient position. The foot-feed requires no alteration or adjustment for different positions of the head. The quill is graduated in $\frac{1}{16}$in., and a depth stop is fitted. The table is counterbalanced. Holes up to $\frac{9}{16}$in. may be drilled; the feed is 8in., and the movement of the head 7in.

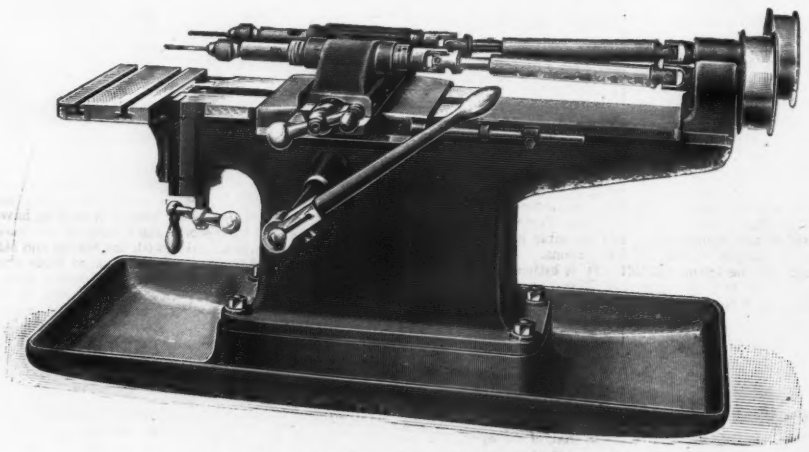


Fig. 12—TWO-SPINDLE DRILL—CHARLES TAYLOR

A somewhat similar machine with two-spindle is shown in the centre of the group. One of the spindles is fixed, the other is carried in a movable head. They can be set to within 2in. centre to centre, and are 7¾in. from the pillar. The down feed in this case is 1¾in.

Another form of two-spindle drill is also shown; in this case both the spindle slides can be moved sideways, and power is transmitted to the drills through universal joints and telescopic shafts. One of them has separate vertical adjustment, so that both may be started to cut at the same time. The table is raised and lowered by a screw, and the feed is effected by a hand lever clamped to a quadrant carrying the weight that counterbalances the slide. The distance from centre of spindle to face of column is 5¾in., the vertical feed is 3in., and the drill centres may be brought within 1¼in. of each other, or opened out to 4in. apart.

We illustrate in Fig. 14 a horizontal boring machine by the same makers which will require little description, as practically all the working parts are clearly shown. A good point is the coupling together of the boring head and the outboard support so that they may be raised simultaneously, this is effected by the use of a splined shaft. The boring head is counterbalanced; the vertical adjustment is 26in. The table has a cross movement of 24in. The spindle has speeds varying between 2 and 150 revs. per minute, with a two-speed countershaft, and a reverse. Four steps are provided now to meet new requirements in place of the three shown, and with the back gear sixteen rates of revolution are given. The feeds are obtained by belt, and are three in number. The spindle can be moved in and out by rack and hand wheel, and has a feed of 24in. For convenience of adjustment a hand wheel is brought close up to the boring head.

A couple of small machines made by Chas. Taylor, of Bartholomew-street, Birmingham, are shown by Figs. 12 and 13. One is a two and the other a four-spindle drill, but the right-hand part of the latter is practically identical with the former. The spindles are driven by single pulleys through universal joints and sliding shafts, the drill carriage with the two drills being moved forward by the long lever in front. The distance apart of the drills is regulated by a cross screw. A slight modification of this arrangement is used in the left-hand part of the four-spindle drill, the spindles having independent vertical instead of horizontal movement. The largest drill these little machines are intended to take is ⅝in. diameter, and the belt is 1in. wide. The maximum horizontal distance apart of the holes is 6½in., the minimum 1¼in., the longitudinal travel 7in.

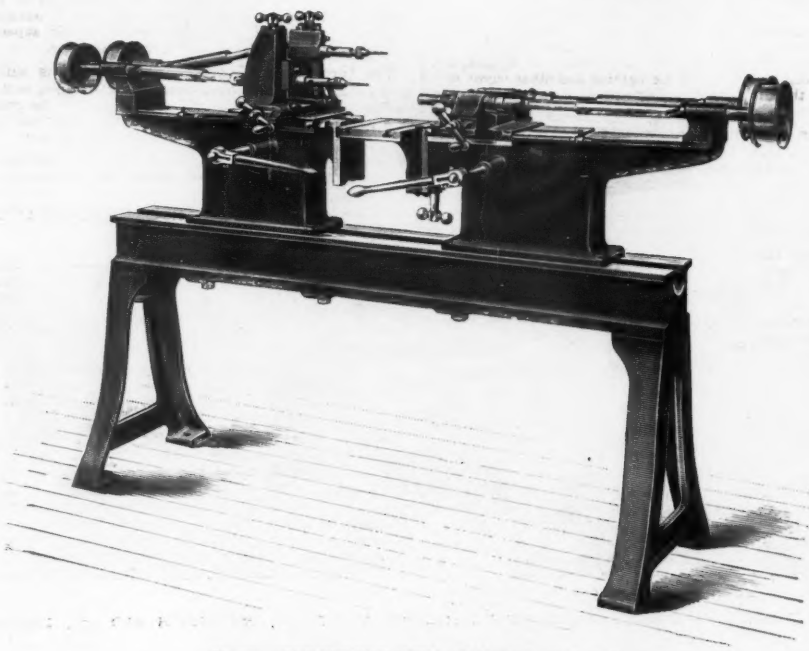


Fig. 13—FOUR-SPINDLE DRILL—CHARLES TAYLOR

Bradford Engineering Society.—The first of two lectures on "Friction and Lubrication" was delivered by the President, Professor G. F. Charnock, A.M. Inst. C.E., M.I. Mech. E., in the Lecture Hall of the Technical College, on the 27th November, before a large audience of members. In emphasising the importance of the subject, the lecturer mentioned that the total horse-power of all the steam engines at work in the United Kingdom at the present time is estimated at not less than 18 millions, and there is little doubt that considerably more than half of this enormous amount is consumed in overcoming friction. Taking a good engine working at full power, from 6 to 8 per cent., and at quarter power from 30 to 40 per cent. of the total power developed, is wasted in friction at the main bearings. In many mills, fitted with first-class arrangements for transmitting power, to drive the shafting alone requires from 20 to 30 per cent. of the useful work done by the engine, and, no doubt, in many cases this is greatly exceeded. There is much room for progress in the direction of the reduction of avoidable sources of loss by more careful attention to the laws of friction and to more scientific methods of lubrication. The whole tendency of modern manufacturing is to run machinery at the highest possible speed. The textile industries are no exception to this rule, and as is well known, speeds are increasing year by year in spinning and other operations. The conditions under which lubrication has to be effected are becoming more and more difficult, if not impossible, to carry out on the old-fashioned lines. Millowners are beginning to understand that the selection of the most suitable lubricant for any given case can only be made by reference to scientific principles in combination with proper testing and experimenting. In support of this statement, the lecturer gave a concise account of the investigations and research carried on by the most eminent authorities up to the present time;

RAILWAY MATTERS.

THE Caledonian and London and North-Western Railways have started a new express goods service between Glasgow and London.

THE Belfast electric tramways, which have been undergoing conversion from horse traction for the past ten months, were opened on Wednesday.

A LOCOMOTIVE testing laboratory is to be built in Germany at the Grunewald Works, on similar lines to that at the St. Louis Exhibition. It is to be in charge of Professor Von Borries.

THE new electric tramways between Dewsbury and Berkenshaw were inspected last week, on their completion, by Major Druitt, of the Board of Trade. Messrs. Dick, Kerr, and Co. were the contractors.

A RESOLUTION has been carried by the Legislative Assembly of New South Wales for the construction of a line of railway from Maitland to South Grafton. The total length of the line will be 310¾ miles and the estimated cost £2,697,320, exclusive of lands and compensation.

ACCORDING to Reuter, the Council at Pretoria has sanctioned the completion of the Pretoria-Rustenburg and Krugersdorp-Zeerust lines, and has authorised the conclusion of an agreement with Cape Colony for the construction and working of the Mafeking and Ottoshoop lines.

WE are informed that Mr. D. R. Mason, Midland Railway Company's goods agent at Bradford, has been appointed goods agent at Sheffield, in succession to Mr. W. C. Sowerby, who has retired from considerations of health. Mr. Mason has been in the service of the Midland Company since July, 1875.

THE first through goods train was run last week on the new line of the Great Central Railway Company from Neasdon to Grendon Underwood. It is probable that the line will be open for passenger traffic in February next. Part of the new line is the joint property of the Great Western and Great Central Companies.

A REUTER'S telegram from New York states that the directors of the Chicago, Milwaukee, and St. Paul Railroad have formally authorised the extension of the line to the Pacific Ocean. The cost is estimated at £10,000,000. It is understood that the executive committee will take up the plans for financing the extension to-day.

SANCTION has been given to a scheme, known as the Kashmir, for an installation of a hydro-electric station capable of furnishing 17,000 horse-power, which is to supply power for an electric railroad, 200 miles in length, in the State of Mysore, and for a large dredging outfit, and for lighting and other power purposes. It is thought that the single-phase alternating current system may be adopted on this line.

A SCHEME of the Midland Railway to run a line to Huddersfield is under consideration. The town is at present served by the London and North-Western and the Lancashire and Yorkshire systems. It is stated that land for the proposed Midland station at Huddersfield has been in the possession of the company for some time, and that a branch line from the neighbourhood of Thornhill has already been marked out.

THE South-Eastern and Chatham Railway announce that a special train, composed of first and second-class lavatory carriages and a restaurant car, will leave Boulogne for Marseilles, Cannes, Nice, Mentone, and Monte Carlo, and other French Riviera stations, on Friday, December 22nd, in connection with a special express train from Charing Cross Station at 2.15 p.m., by the short sea route *vid* Folkestone and Boulogne.

A REPORT has been made to the Board of Trade by Colonel von Donop on the electric tramway accident which occurred at Madeira-hill, Ramsgate, on August 3rd last. There were, fortunately, only six passengers on the car at the time, but four were injured, and the car fell over the cliff. The accident was due to excess of speed, and the responsibility is attributed to the motorman, who does not appear to have used his brakes judiciously.

IMPORTANT reductions are announced by the District Railway Company, to come into operation on December 1st, in the single journey fares over the inner circle portion of its system. In no case will the fares on this portion of its system be in excess of 4d. first class and 2d. third class single. The fares from Earl's Court, High-street (Kensington), Gloucester-road, South Kensington, Victoria, &c., to all City stations to Aldgate East will now be 4d. first and 2d. third instead of 6d. first and 3d. third as at present.

THE London and South-Western Railway Company is about to open a line connecting Bentley and Bordon, two Hampshire agricultural villages about 4½ miles apart. From a junction on the Alton side of Bentley Station the new railway runs through the ancient parish of Binsted, and, passing near Kingsley, terminates close to Woolmer Forest. At Bordon ample provision has been made for the rapid handling of troops. The platforms are 525ft. long, and the goods yard contains a fine loading dock 600ft. long and 40ft. wide.

FOR the electric conductor, or third rail, the New York Central Railway Company has adopted the inverted or suspended type of construction, the contact being on the under head of the rail. The rail is made in special rolls of dumbbell cross sections with flattened heads, and will be protected with continuous tight-fitting wooden sleeves or blocks, which cover the entire surface of the rail except the contact surface. At crossings and in important yards an overhead conductor will replace the third rail. It is anticipated that the contact shoes, even at maximum speed, will engage automatically with the conductors.

A STATEMENT has been issued by the Austrian Minister of Railways on the railway situation in that State, showing that out of the total length of line worked, viz., 20,288 kiloms., in 1903, 12,016 kiloms. were worked by the State, and 8242 kiloms. by private companies. The most interesting feature in this statement is that which reveals the difference between State and private enterprise, which in this case works out to the disadvantage of the State. The number of passengers carried by the Austrian railways in 1903 was 176,460,000, the number per kilometre being 265,000. This is a reduction of 3·24 per cent. on the result of 1902. The goods transported worked out at 564,000 tons per kilometre worked. The total receipts amounted to 663,000,000 crowns, or 32,691 crowns per kilometre worked. But while the amount per kilometre is but 23,246 crowns on the State lines, it is 46,504 crowns on the companies' lines.

THE South-Eastern and the London, Chatham and Dover Railway Companies notify their intention of applying to Parliament in the ensuing session for an Act to empower them to make and maintain a railway (No. 1) wholly in the parish of St. Nicholas, Rochester, commencing by a junction with the South-Eastern Company's Chatham central line and terminating by a junction with the Chatham Company's main line; two widenings of the latter railway; and a widening of the South-Eastern Company's Ashford and Hastings branch line, commencing at or near the eastern end of the up-platform of Ore Station, and terminating by a junction with widening No. 2, authorised by the Act of 1902 of the two companies. Power will also be sought for to transfer to and vest in them or their Managing Committee the undertaking of the Crowhurst, Sidley, and Bexhill Railway Company; to authorise the abandonment of the railways and works sanctioned by the Tenterden Railway Act, 1899;

NOTES AND MEMORANDA.

Power says that Austrian engineers are studying the possibilities of peat gas as a source of power.

THE Hongkong telephone service is now undergoing almost total reconstruction, and all the wires will be put underground where possible.

IT is said that steel fly-wheels having a tensile strength of about 27 tons per square inch will stand a speed 90 per cent. greater than fly-wheels made of cast iron.

IT has been decided to hold the Agricultural Show at Cairo biennially instead of annually, and no show will be held next spring. The next show will be held in 1907.

IN the petrol-engine cylinder, the highest temperature reported is in the neighbourhood of 4000 deg. Fah. This is at the hottest portion of the exploding mixture of gas and air.

IT is estimated that the substitution of high-pressure incandescent gas for ordinary gas burners at Broad-street Station will save £200 a year, although the candle-power has been increased from 8000 to 40,000.

IT appears from Tokio papers that Japanese naval experts have decided that their future battleships must have a displacement of 22,000 tons and carry an armament of fourteen 12in. guns. The speed will be 20 knots.

THE total expenditures of New York City for the year 1906 will be nearly £23,400,000. The total budget, as adopted by the Board of Estimate and Apportionment on October 31st, is £23,361,000. This is an increase of about £1,400 000 over the appropriations for 1905.

IN sprinkler systems using a shower of water as fire protection. the perforated pipes require from 3 to 8 quarts of water per inch of shower per minute, varying with the pressure and number and size of holes. A pipe 100in. long requires from 75 to 200 galls. per minute.

A 40-MILE pipe line to furnish water to construction camps upon the eastern end of the Western Pacific Railway is being installed. Water will be secured at a spring in Skull Valley, and pumped to the edge of the Great American Desert, requiring three pumping stations to overcome local elevations.

THE first by-product coke oven plant to be established in India is, says *Indian Engineering*, to be installed at the East Indian Railway Collieries. A Manchester firm is executing the order for the required plant, which will, it is said, supersede the processes heretofore in operation in this connection.

THE furnace as a means of ventilation is said to be more economical in deep mines than in shallow ones, as it acts by heating a column of air; the higher that column the greater will be the difference in the weight of air in the upcast and downcast shafts, and consequently the greater the motive power.

THE heavy current required to start induction motors used for driving pumps in mine workings can be reduced to a large extent by putting a by-pass in the pipe line, so that the pump, which has to start up under the full head of water, will, until it has attained its normal speed, have to pump only a fraction of its regular load.

OFFICIAL sanction has been given recently to the use of basic Bessemer steel in the erection of bridges for Austrian State railroads. In other countries, notably Germany and Switzerland, Thomas steel has been sanctioned for bridge building, while Austria has required until now that in all such constructions open-hearth steel be employed.

MUCH uneasiness is being felt at Upleatham, a mining village in North-east Yorkshire, owing to gradual subsidence of land under which are extensive iron mines. The population, which numbered originally 800, is now only seventy. In five years twenty-five houses, a Primitive Methodist chapel, a school, and three large farmhouses have fallen.

THE Baltic Coast lacks big docks that can accommodate merchant vessels. The harbour authorities at Malmö, on the Sound, in the extreme south-west of Sweden, are about to supply this want by building there a dry dock, 175½ yards in length, 91ft. in width, and 24ft. 2in. in depth. Hitherto Swedish and Danish vessels have had to make use of German dry docks.

ACCORDING to the *Japan Weekly Mail*, the steam tonnage under the Japanese flag has increased from 197 vessels, of 511,661 tons, in December, 1903, to 283, of 726,310 tons, in July, 1905, an increase of 86 vessels, of 214,642 tons. In addition to this total about 40,000 or 50,000 tons are building for Japanese owners, and there are some 88,000 tons of steamers, prizes of war, to be placed on the Japanese register.

ACCORDING to the *Electrical Engineer*, experiments were recently carried out in Bilbao Harbour by Señor Torres Quevedo with a view to ascertaining the possibility of maritime navigation by means of power transmitted by Hertzian waves. The propellers of a boat were worked in the harbour by electric waves transmitted without wires. The inventor considers it possible to apply his system to special navigation.

COMPARISONS of tests made in California give the following relations between the local coal and crude oil: One gallon of California crude oil weighs 7·6 lb.; 42 galls. equals 1 bbl., and 2½ bbl. weigh 718 lb. This, according to the *Engineering and Mining Journal*, is approximately equal to one short ton—2000 lb.—of coal in actual use under the ordinary horizontal-return tubular boiler. In locomotive practice, 3½ bbl. of crude oil—42 galls.—at 7·6 lb. per gallon, is 1037 lb., and this, it is stated, is approximately equal to 2000 lb. of coal.

A DAM 90ft. high and 350ft. long is to be constructed on the river Sihl in the canton of Schwytz, Switzerland, in order to impound water in a lake as a storage reservoir for the use of an electro-hydraulic plant on the shore of Lake Zurich. The area of the lake will be two square miles, and its cubic capacity about 93,000,000 cubic metres—25,360,000,000 gallons. The head of water obtained will be 480 m.—1575ft. It is estimated that the plant will have a continuous capacity of 20,000 horse-power, or a capacity during ten hours per day of 45,000 horse-power.

ACCORDING to the *Engineering Record*, muffling tanks to minimise the noise of exhaust steam are sometimes needed, as was the case in America some time ago. A 10in. by 12in. engine running at 250 revolutions per minute had an exhaust pipe that made a number of sharp turns before entering a riser surmounted by an exhaust head. The noise was so serious that the tenants threatened to leave if it was not stopped. The remedy was merely a plain shell having a volume twenty times that of the cylinder of the engine and inserted in the exhaust pipe at the first turn nearest the engine.

THE first application of the thermit process for pipe welding has recently been made in New York City for a refrigerating company. The pipes are laid in the ground and are used as service return pipes in the delivery of liquid ammonia—180 lb. pressure—to various cold-storage houses along the street. Twenty-nine 1¼in. and twenty-seven 2in. joints were welded. The pipe was welded on the ground to lengths varying from 40ft. to 100ft., then placed in the ditch, cuts made for connections and the final welding done with the pipe in place. On the 2in. line an expansion bend was placed, while on the 1¼in. this was not thought necessary.

MISCELLANEA.

EXTENSIONS at the Dundee Electricity Works, to cost £70,000, are under consideration.

DURING this year's navigation season just ended 1,072,000 tons of ore were shipped from Lulea.

WE understand that Messrs. Vickers, Sons and Maxim have commenced the construction of a large first-class cruiser for the Russian Government.

EARLY next year it is expected the Bolton Corporation will take steps towards commencing the construction of new waterworks at a cost which will run well into six figures.

THE officer administering the government of the Gold Coast telegraphs that the amount of gold exported from the colony and Ashanti in the month of October was 16,421 oz., valued at £61,906.

THE first-class armoured cruiser Warrior was successfully launched from Pembroke Dockyard on Saturday afternoon. The estimated maximum speed which the ship will attain is about 22½ knots, and the cost of the vessel, with fittings and equipment, is put at £1,173,946.

GREAT efforts are being made to get the Dover Naval Harbour completed by next October, a year in advance of the time originally specified. It was reported at the Dover Corporation meeting on Tuesday that the contractors, Messrs. Pearson, are being pressed by the Admiralty to accomplish this.

THE Bradford Sewage Committee have decided to seek borrowing powers for £275,000 to cover the cost of the Esholt purchase and of other lands acquired in connection with the sewage scheme. Mr. Garfield, the sewage engineer, is preparing plans of the sewage disposal scheme for submission to the Local Government Board.

THE Todmorden Town Council on Wednesday decided to promote a Bill in Parliament seeking powers, among other things, to authorise the Corporation to provide for the running of motor omnibuses within and without the borough in connection with the tramway systems of the corporations of Halifax, Rochdale and Burnley.

AT a meeting of the Stourbridge District Council on Monday the Electric Powers and Railway Committee reported in favour of selling or leasing their provisional electricity order, and of applying to the Board of Trade for a further extension of time for the order, to enable them to negotiate with that object. The report was adopted.

THE United States Board of Naval Construction on Tuesday rejected the recommendations of the General Board, of which Admiral Dewey is chairman, for additional torpedo boats and destroyers, and an increase of the tonnage of warships from 16,000 to 18,000 tons, the latter because the plans would not support the increase of armament, and at the same time allow the attainment of the required speed.

THE Spalding Urban Council are reported to be co-operating with the promoters of a large water scheme for South Lincolnshire. The springs at Bourne and Deeping are to be utilised, and it is purposed to make reservoirs and to erect water towers at Weston and Little Sutton, and to supply the district from Bourne to Spalding, Holbeach and Sutton Bridge, including the neighbouring villages, a distance of something like 25 miles.

THE town authorities of Kiel, the German naval station at the northern entrance to the Kaiser-Wilhelm Canal, have decided to grant free instruction in the town technical school, beginning with April 1st, 1907. On April 1st, 1906, the Royal Higher School of Shipbuilding and Machine Construction will take up its quarters in its new building at Kiel, and the town has resolved to seek the approval of the Government for its proposal to establish a third department of shipbuilding, machine construction, and locksmiths.

IT is reported from Brussels that the well-known geographers and Arctic explorers, Lecointe, Arktowsky, Nordenskjöld, and Bruce, are arranging, with the co-operation of Nansen, Sverdrup, the Duke of Orleans, and the Duke of the Abruzzi, a joint expedition to the North and South Pole. During the course of the coming year the Belgian Government will invite these and other well-known explorers to Brussels to arrange details. It is not expected that the expedition will be ready to start before three years.

THE Agent-General for Natal has received the following communication from his Government:—"The average low-water depth at the entrance to Durban Harbour for the three months ended September 30th last was 29ft. 6in. The number of deep-draught steamers using the harbour is rapidly increasing, and each month vessels drawing 29ft. and over are satisfactorily dealt with. The greatest draught, in May last, was 30ft. 7in. Forty vessels drawing 26ft. and over entered and left the harbour during the past nine months, as compared with twelve for the whole of the year 1904."

A REPORT from Canton Vallais states that the completion of the Simplon Tunnel is causing considerable difficulty. One of the parallel borings has been bricked in, but it was proposed to leave the other unfinished for the present. However, a subsidence of the roof has set in, which necessitates the immediate bricking in of the second boring, through which there now flows an abduction canal carrying 350 litres of water per second. This water will now have to be diverted for some 1000 m. and led into the first and principal boring. This development will involve a material postponement of the date of opening.

TWO of the four large barges, of heavy timber construction, ordered by the Admiralty about two months ago from Mr. Duncan Morrison, of Inverkeithing, for the use in connection with boring operations at the naval base being formed at Rosyth, have now been towed to the scene of their work, and a number of workmen who are to be employed in connection with the boring and other operations have passed medical examination as to their fitness. The remaining two barges are being rapidly proceeded with, and will also soon be put to service. Boring was carried on at Rosyth, in connection with the new works, for some considerable time by a contractor, but this work was suddenly stopped more than a year ago. Now the Admiralty are taking the boring into their own hands, and this fresh evidence of their determination to proceed with the naval works is regarded, locally and otherwise, with satisfaction.

THE "electrification" of Snowdon district is progressing apace, and soon the requisite power will be applied to the slate quarries and railways of Snowdonia. Messrs. Bruce, Peebles and Co., of Edinburgh, have practically completed, for the North Wales Power Company, a scheme for generating electricity from the source of supply, Lake Llydaw. This covers an area of 120 acres, and will be available for the slate quarries and for the North Wales narrow gauge railway, which it is proposed to extend from Rhyddu to Carnarvon. Another scheme contemplated is the harnessing of Lake Eigiaw, in the Conway Valley. This will provide a double service between Carnarvon and the district well served by the Cambrian Railway. Nor does this end the list, for Eigiaw is in the Conway Valley, and it is considered will supply electric energy as remote from the lake as Rhyl. So far Bala remains untouched for electric energy or for the supply of towns. It is conjectured that its turn will come.

BORING AND DRILLING MACHINES

(*For description see page 510*)

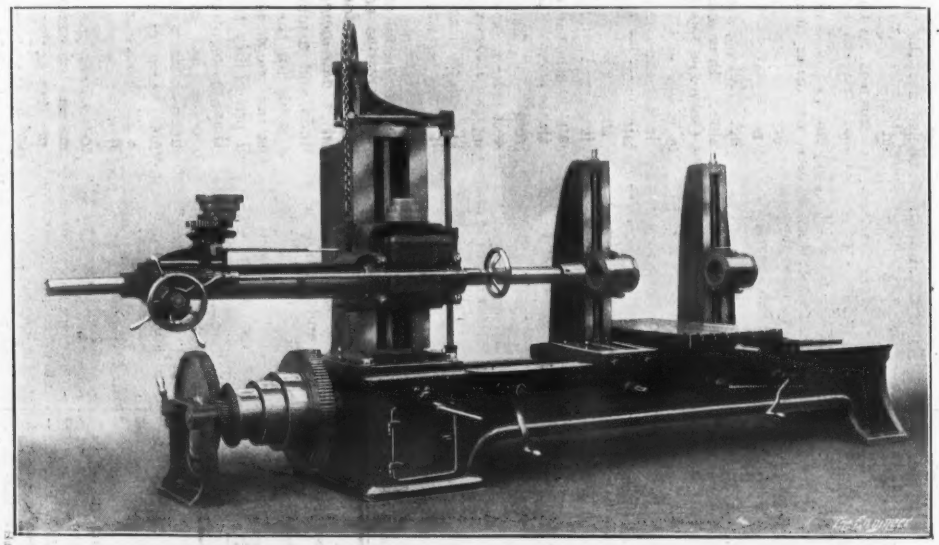


Fig. 14—BORING MACHINE—J. PARKINSON AND SON

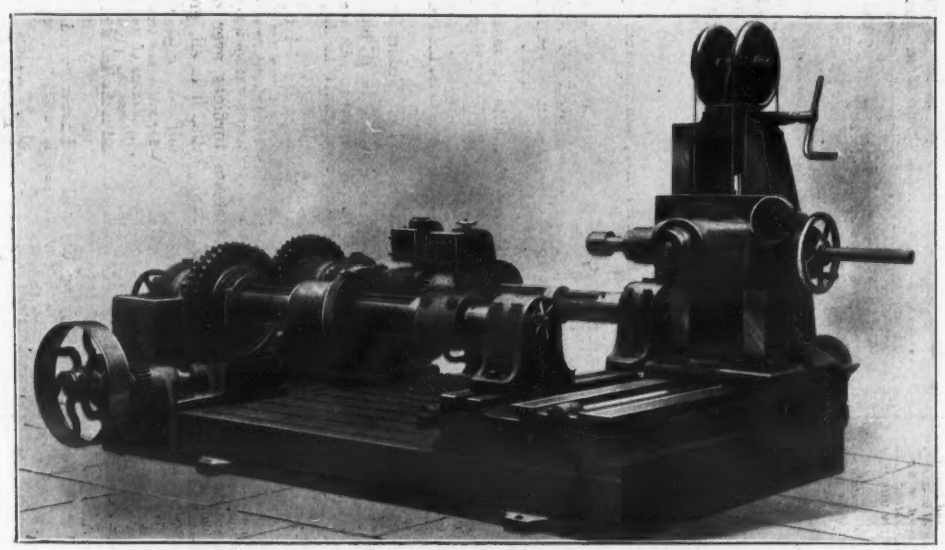


Fig. 16—DOUBLE LOCOMOTIVE CYLINDER BORING MACHINES—JAMES SPENCER AND CO.

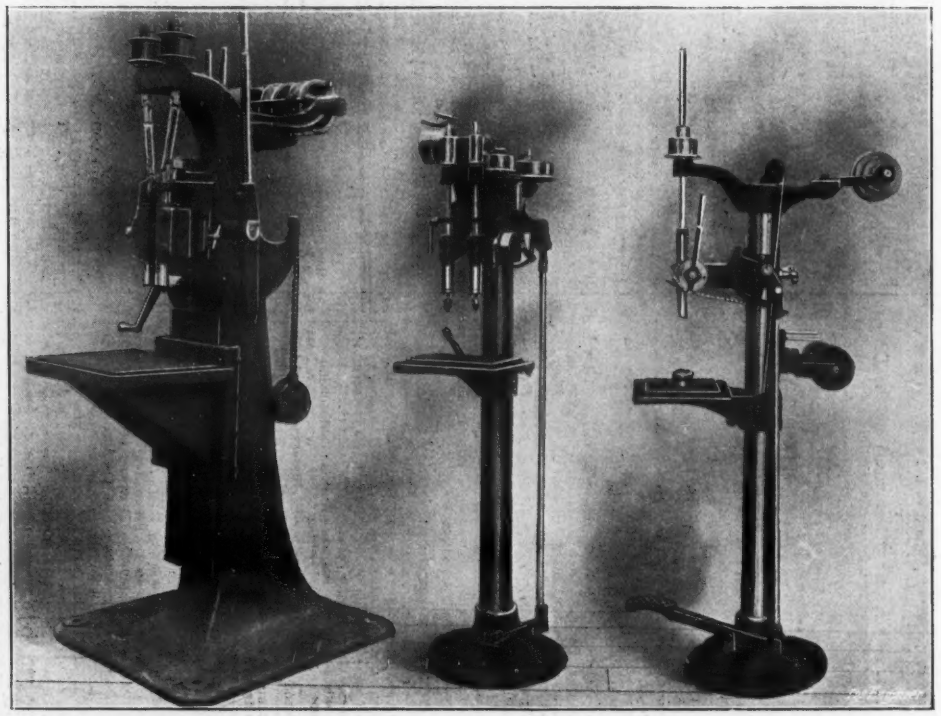


Fig. 15—SENSITIVE DRILLING MACHINES—J. PARKINSON AND SON

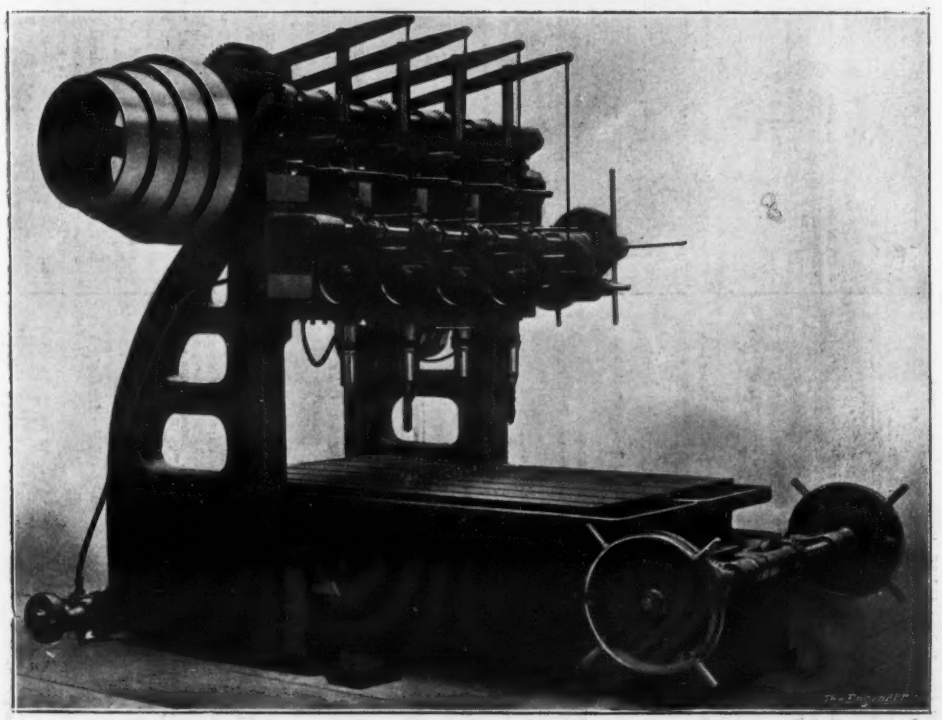


Fig. 17—FOUR-SPINDLE DRILLING MACHINE—JAMES SPENCER AND CO.

FOREIGN AGENTS FOR SALE OF THE ENGINEER.

AUSTRIA.—F. A. BROCKHAUS, 7, *Kumpfgasse, Vienna.*
CHINA.—KELLY AND WALSH, LIMITED, *Shanghai and Hong Kong.*
FRANCE.—BOYVEAU AND CHEVILLET, *Rue de la Banque, Paris.*
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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. G. (St. Helens).—Your letter has been forwarded.

A. D.—Your best course is to apply to several of the large engineering firms and ask if they have an opening for an apprentice.

H. L. R.—See (1) Haldane and Gee's or S. P. Thompson's "Electrical Engineering," (2) "Structural Steel Work," by Farnsworth. (3) See Robinson's "Gas and Oil Engines," and Bryan Donkin's "Gas and Petroleum Engines."

F. (Southfield).—Possibly *La Ingeniria*, a journal published in Buenos Aires, would meet your requirements. The Buenos Aires office is Calle Florida 230 (altos), but inquiries regarding the paper will be answered by E. Henderson and Co., billiter-square-buildings, London, E.C.

B. (Liverpool).—You might try Caird and Rayner, 777, Commercial-road, London, E.; Blair, Campbell and McLean, Limited, Woodville-street, Glasgow; Fawcett, Preston and Co., Limited, Liverpool; Mirrlees, Watson and Co., Limited, 45, Scotland-street, Glasgow; Fullerton, Hodgart and Barclay, Limited, Vulcan Foundry and Engine Works, Paisley; Isaac Storey and Sons, Limited, Empress Foundry, Manchester; or George Scott and Co., 44, Christian-street, London, E.

PUMPS.—"The Principles, Construction, and Application of Pumping Machinery" (Steam and Water Pressure), by Henry Davey, London, Charles Griffin and Co., Limited, price 21s., will probably give you all the information you require. You might also try "Pumps, their Principles and Construction," by J. Wright Clarke, London, B. T. Batsford, price 3s. 6d. net; and "Notes on the Construction and Working of Pumps," by Edward C. R. Marks, Manchester, The Technical Publishing Company, Limited, price 3s. 6d.

A. H. M. (Dartford).—(1) In practically all the tanyards where the effluent has to be raised from one level to another this is done by means of a chain-and-bucket pump. This consists of a series of buckets with an endless chain, something like a dredger. In but few factories, so far as we are aware, is the deposit from the effluent pressed into solid form. In one instance an experiment was made, some years ago, on a small scale, the sludge being precipitated and pressed in sand filters. The trouble with ordinary press cloths was that they rapidly rotted under the action of the sludge. However, if some cheap material such as sumach bags were used the cost might not be very high. (2) We would suggest that you should apply to Mr. Edward Wilson, Engineer, Exeter, and to Messrs. S. H. Johnson and Co., Limited, Stratford, E.

STANDARD HEXAGON BARS.

A well-known firm of engineers writes to us that they have been unable to obtain black hexagon bars rolled either to standard Whitworth size across the flats or to $\frac{1}{64}$ above standard, to allow of cleaning up to fit standard spanners. They have written to many firms, but find it impossible to obtain standard sizes. We shall be glad to hear from any firms which do make what is required.

INQUIRIES.

CORRUGATED PIPES.

SIR,—Can any of your readers tell me where pipes made of corrugated sheet iron may be purchased? E. B.
November 28th.

BELT DRESSING.

SIR,—Can any of your readers tell me where a belt dressing known as "Cling Surface" is to be obtained? P. C.
November 27th.

TAYLOR'S RINGS.

SIR,—I understand that rings similar to Taylor's rings, made of corrugated copper and asbestos, are manufactured somewhere in Scotland. Can any of your readers give me the address of the makers? C. E.
November 28th.

MEETINGS NEXT WEEK.

INSTITUTE OF MARINE ENGINEERS.—**Monday**, December 4th, at 8 p.m., at 58, Romford-road, Stratford, E. Adjourned discussion on "Decimal and Metric Systems."

ROENTGEN SOCIETY.—Thursday, December 7th, at 8.15 p.m., at 20, Hanover-square. Ordinary general meeting. Paper, "The Spontaneous Action of Radium and other Bodies on Gelatine Media," by Mr. J. Butler Burke, M.A.

SOCIETY OF ENGINEERS.—Monday, December 4th, at 7.30 p.m., at the Royal United Service Institution, Whitehall. Ordinary meeting. Paper, "The Grindleford Stone Quarries and their Working," by Mr. Benjamin L. Bradley, Patron, Perm. Way Inst.

THE COLD STORAGE AND ICE ASSOCIATION.—Wednesday, December 6th, at 8 p.m., at Caxton Hall, Caxton-street, Westminster, S.W. Paper, "Cold Storage Accommodation for Hotels, Butchers, and Provision Dealers," by Mr. Hal Williams, A.M.I. Mech. E., A.M.I.S.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—**Thursday**, December 7th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Paper, "The Charing Cross Company's City of London Works," by Mr. W. H. Patchell, Vice-president.

THE INSTITUTION OF CIVIL ENGINEERS.—**Tuesday**, December 5th, at 8 p.m. Ordinary meeting. Discussion on paper, "The Steam Turbine," by the Hon. Charles Algernon Parsons, C.B., LL.D., F.R.S., and George Gerald Stoney, MM. Inst. C.E. Wednesday, December 6th, at 1.16 p.m. Students' visit to the Erith Slipway of Messrs. William Cory and Son, Limited.

SOCIETY OF ARTS.—Monday, December 4th, at 8 p.m., at John-street, Adelphi, W.C. Cantor Lectures: "The Measurement of High-frequency Currents and Electric Waves," by J. A. Fleming, D.Sc., F.R.S. (Lecture II.) Wednesday, December 6th, at 8 p.m. Ordinary meeting. Paper, "The Manufacture of Sugar from British-grown Beet," by Sigmund Stein. Thursday, December 7th, at 4.30 p.m. Indian Section. Paper, "The Partition of Bengal," by Sir James Bourdillon, K.C.S.I.

DEATH.

On the 18th November, 1905, at Howth, Co. Dublin, HENRY BARCROFT, D.L., of The Glen, Newry, Co. Down, aged 66 years.

THE ENGINEER.

DECEMBER 1, 1905.

THE ATLANTIC TURBINE.

THE Carmania constitutes the most magnificent experiment in mechanical engineering ever carried through. Let the outcome be what it may, no one can in the future say that the steam turbine has not had fair play. The Cunard Company and J. Brown and Co. have kept Great Britain in the front rank of progress, and the courage, the audacity, and the skill of those who designed and constructed the engines of the great ship ought to elicit a chorus of approval even from our German rivals—the rivals who alone challenge us for the supremacy of the Atlantic. But while we hasten to put on record our appreciation of the really great qualities without which the Carmania could not have been fitted with turbine engines, we must not forget that after all she, or more strictly speaking, her propelling machine, is on trial. Many months must elapse before it can be asserted that a sufficient success has been secured. Attention centres on the ship. Her performance will be watched with eager eyes, for on it depends the direction which progress in marine propulsion on the Atlantic must take for many years to come, and it is expedient to consider now what are the points in favour of the new as compared with the old system, what are its drawbacks, and wherein lie the prospects of success or of failure.

The steam turbine has been before the world for many years. It is only recently that it has acquired importance as a candidate for ocean propulsion. It must be dealt with in two ways. We have first to consider its actual, and, secondly, its economical efficiency. The experience already obtained in inland waters—as, for example, with The Queen—goes far to prove that the turbine is trustworthy in all weathers, and that it will not break down. But it is none the less certain that high speeds of revolution are not suitable for marine propulsion, not because the engines are incompetent, but because the high-speed screw, necessarily small in diameter and of fine pitch, is at once inefficient as a propeller and unfit for rough practical use. This fact was early recognised at Fairfield; and the result was the production in order to secure sufficient vane speed, of the biggest steam turbines ever made, turning round at a velocity little, if at all, greater than that usual now not only in men-of-war, but many other ships of various nationalities. But a direct result of keeping down speed to 180 revolutions or so per minute is that the machinery is very heavy. It may be admitted at once that the weight of the engines of the Carmania is if anything greater than that of the Caronia, which has quadruple-expansion piston engines. The boilers and auxiliaries are about equal in weight. The only saving in space is a little in height. Seeing that the engine-room skylights are more than 60ft. above the lower platform, and that the great well at the bottom of which the engines lie is entirely unoccupied, the saving is of no value. A great advantage is gained, however, by the absence of crank shafts, always very heavy and very costly; easily broken, and replaced with difficulty. The propeller shafts, again, are less in diameter than they would have been even if three screw crank engines had been used. The stresses are practically quite uniform with the turbine; with piston engines they are not, and the shafts must be strong enough to deal with the maximum turning moment, or torque, which is much in excess of such an average as the turbine develops. The engines set up no vibration; there is neither pounding nor knocking. But the engines in a ship cannot be studied alone; they must be taken with the propellers. The Carmania has three, and the central propeller is the weak spot. That there is vibration, quite limited in its range, but very considerable in amount, is certain; and it appears to be due to the "thrash" of the blades past the sternpost and rudder. Whether it will be found possible to use only two propeller shafts in other ships, or to improve matters by moving the central propeller further forward, and away from the sternpost, remains to be seen. As matters stand, however, forward of a short distance from the stern there is really no vibration whatever. The saloon passenger, at all events, will find it difficult to say whether the ship is under weigh or not. This absence of vibration is the dominant point so far in favour of the turbine. It is, beyond doubt, an immense advantage. It means much more than comfort for the passengers, because all vibration is detrimental to the hull and fittings of all kinds, and machinery great and small. This so far sums up the good points of the turbine. It does not weigh less, or occupy less space, and in all probability turbine machinery is more expensive than piston engines, and will be for some time to come; but on this point we have no higher qualification for speaking with authority than mere surmise, based on a long visit to the engine-room, and a knowledge of what steam turbines really are, can give.

In the next place, we have to consider the question of economy of fuel. No one can tell except by calculations which are more or less approximate what is the horse-power developed by the Carmania's main engines. It is assumed to be about 20,000 horse-power, or, say, the same as that of the quadruple expansion engines of the Caronia. Now Mr. Parsons does not claim more for his turbines than

that they are about as economical as quadruple-expansion engines—that is to say, that the Carmania and the Caronia will burn ton for ton of coal. But we are told that while the best work of the Caronia was 19 knots, that of the Carmania was 20 knots. At these very high speeds it is not improbable that the power necessary varies as the cubes of the velocities, or nearly so. Now, the cube of 19 is 6859, while that of 20 is 8000. If the Caronia ran at 19 knots, with 20,000 horse-power, then the Carmania would have wanted 22,300 to attain 20 knots. Whence did the additional power come? Are we to assume that the net output of the turbine is better than that of the quadruple engine? or are the propellers more efficient from some cause which has yet to be ascertained? These are questions which remain to be answered. The fact is that the power of steaming at an extra knot when desirable is an immense advantage in favour of the turbine. The greater efficiency which it represents ought to mean economy in fuel. Taking the total consumption for the Carmania and her sister the Caronia as the same, the latter would traverse in twenty-four hours 456 nautical miles and the former 480 nautical miles. But the sea speed of both is to be 18 knots, which permits thirteen trips out and home to be made in a year. The only commercial advantage of the high speed of the Carmania must be that at the reduced speed she will burn less coal than her sister. At the present moment, outside a very small circle, no one knows even approximately what the Carmania burns. It is, therefore, mere waste of time and ink to speculate on the point further than we have done. If the turbine is not more economical than the quadruple-expansion engine, and the coal consumption is the same in both ships, then the horse-power must be the same, and the extra knot must be due to an improved action of the propellers. It may, however, be that for some reason not stated the turbines developed more power than the piston engines. Such questions cannot be settled until both ships have made a sufficient number of runs to furnish the world with an adequate basis for comparison.

SPECIALISATION AND SCIENTIFIC PROGRESS.

WE live in days of specialisation, and the appeal in any vexed question is to the authority who by reason of experience and repute is a recognised specialist in any particular branch of science. We leave, however, for a moment the question of the practical definition of a specialist, to study the problem of his evolution which attracts the attention and much illumination on, the matter is contained in Dr. W. M. Thornton's inaugural address as chairman of the Newcastle Section of the Institution of Electrical Engineers. The evolution of the specialist is after all inseparable from the evolution of the subject with which he may be associated. If the man or men working at any problem are deficient in general knowledge, particularly that pertaining to physics, there is the risk that their energies may only serve to cut a deep rut of isolation for themselves and for their branch of science over whose walls they become unable to look for inspiration. As a result, work becomes stereotyped, and originality is dwarfed by tradition and environment. It is necessary for progress that new ideas and virile intelligence should be called into action. To specialise is necessary, but we must specialise with intelligence, never forgetting that outside the subject we pursue there are a hundred things which influence and bear upon it.

Dr. Thornton's address serves to emphasise the need of a fostering of fruitful fields of speculative scientific research in regard to the unknown "on lines suggested by unique chains of thought, arising from new observations or strong co-ordinated thinking." Much is said concerning the possibilities of the young engineer, fresh from his college training, and Dr. Thornton thinks that "a time of speculative activity almost inevitably follows the completion of a university course," after which should come the patient experimental search which weeds so many from the ranks. The reason for this weeding is not far to seek. Professors and lecturers who get into close touch with their students have only one tale to tell of the difficulty of getting the great majority to think. Examinations do not serve to distinguish the thinker from the competitor whose powers of memory are good. The great need is for co-ordinated thinking, for the study of parallel lines of thought and development. The laws of Nature are wide-reaching, and few be the laws which apply to only one phenomenon or group of phenomena. Similar are the paths along which progress has been made. The general outlines of the magnetic circuits of the electro-magnet in its application to bell or telephone work have their equivalents in the magnetic circuits of electrical generators. The internal combustion engine, vertical or horizontal, can be matched in any grouping of its cylinders by the steam engine. The same laws govern the electro-deposition of copper at Anaconda, as in the first of Daniell's batteries, although in the one case we have the oxidisation of carbon to carbon dioxide in the furnaces of the boilers, in the other a virtual burning up of zinc to zinc sulphate in the internal porous cell. Neither would it be difficult to show the similarity between the superheater—which serves to raise the temperature of steam, wet or saturated, to a higher value—with certain parts of the water-tube boiler in which the water has been converted into steam. From the days of Savory to Bessemer or Swan, the men who have made their mark in engineering history have never been men of a single idea. Specialists in a certain sense they undoubtedly were, but they owed their very repute in the spheres with which their names were identified to a breadth of knowledge of the action of the laws of Nature in other directions, which, by chains of reasoning as fascinating as any fiction of a novelist, they applied to the problems confronting them. Dr. Thornton appeals to manufacturers to assist in the evolution of a race of specialists by granting special facilities for research. Granted that the college graduate is a thinker—we wish that he invariably were—Dr. Thornton suggests that he is promising material to place in the laboratory or test room and set to work on new things, at first under supervision. Of course, there would be a certain amount of waste. "They say no man becomes a good glass-blower until he has broken 10 lb. of glass in the process of learning. There should also be some allowance made for crude ideas in engineering—say, £10 sterling. Fuses cover a multitude of sins in the test room." "One result of college training is to produce a large crop of ideas, more or less crude, out of which finished articles may emerge."

We will pass over an interesting account which narrated the mental processes intervening between an observation that bacteria set themselves along the lines of flow of an electric current, and the invention of a high-tension voltmeter, and enforce our argument for broad specialisation by aid of a suggestion made by Dr. Thornton that the electrical engineer should adopt the microscope, and apply it to studying the permeability of iron. Permeability, of course, depends upon the size and distribution of the crystals of carbide of iron in the metal, which are affected by the heat treatment to which the metal may be subjected. It was therefore urged that permeability might be estimated by polishing a surface on the metal, observing it through a microscope, and comparing it with a standard series of photographs of iron of different grades of permeability. Now an idea like this would never occur to the highly insulated and isolated grade of thinker who knew nothing—and cared less—about metallurgical research and all that it revealed about the micro-structure of alloys. Therefore, we may venture to propound a definition of the true specialist as one whose service to any particular branch of science is founded upon a sane application to his own sphere of the progress and discoveries made in other parallel and remote spheres. This is not even paradoxical, but is entirely true.

AUSTRIAN SHIPBUILDING ENTERPRISE.

THE so-called Austrian torpedo boat contract, about which so much was heard some months ago, will be fresh in the minds of many readers. Austria wanted a number of boats, and it is thought that the order for some might have been secured by the Thames had it been possible to ask a low enough price. This, however, was impossible, owing largely to the high rate of wages in London. Whether the contract would have been placed here under more favourable circumstances or not we need not discuss, the fact is that the Austrians decided to build the boats themselves, and having bought two boats as standards, placed a contract with the Stabilimento Tecnico, of Trieste, for ten torpedo boats and six destroyers, which has been in progress for a number of months, and the work is approaching completion at the present moment. In the meantime the problem which the Naval Department of the Austro-Hungarian Joint Ministry of War has had to settle has been to arrange for the construction of the remaining ten torpedo boats and six destroyers, the construction of which has been sanctioned. As the Stabilimento Tecnico was, and is, largely occupied on Government orders, it was apparently impossible for the works in question to execute further orders for a time, and suggestions were made some time ago advocating the establishment of a ship-building yard capable of building the vessels in Hungary.

The suggestions made in avour of Fiume being selected as a site for the erection of a new ship-building yard led to the presentation of various proposals. In the first place, the Hungarian Minister of Commerce of the time entered into negotiations with an English firm on the subject; secondly, the Danubius Company, of Buda Pesth, which has already built naval vessels for service on the Danube, brought forward a scheme for the establishment of a new yard at Fiume; and, in the third place, a small shipbuilding firm at Fiume entered as a competitor for the construction of the vessels at that port. Some time has been occupied in the settlement of the question, and the final result is the announcement that the order for the sixteen boats has been given to the Danubius Company, which has undertaken to erect and complete the projected yard at Fiume within a period of twelve months. The contract has already been concluded between the Government departments concerned and the company, and has also received the approval of the Crown. It is understood that the vessels are to be constructed on exactly the same lines as those of the Thames-built boats the Huszar and Kaiman. These two vessels, on a recent trial off Pola in the Adriatic Sea, attained a speed of 28 knots per hour, and the same rate has been specified for the boats to be turned out at Fiume. The value of the first half of the order entrusted to the Stabilimento Tecnico is computed at approximately £660,000, and that of the second half given to the Danubius Company at the same amount. We cannot say whether the question of placing the order in England ever actually arose, but it is probable that a low price would have attracted part of it, and might have delayed, at any rate, the creation of the new shipbuilding yard in Hungary, where further orders for torpedo boats and destroyers will presumably be placed with native firms, if the new vessels prove to be wholly satisfactory on trial and in practical work.

The English trade union or labour question has, however, no connection with another scheme for enhancing the shipbuilding capabilities of Austria-Hungary. We refer to the shipbuilding arsenal or yard of the Austrian Lloyd Steamship Company at Trieste. Although in the enjoyment of a very handsome subsidy from the Government, the leading shipping company in Austria has fallen upon evil times; its fleet is, as steamers are regarded in present days, of an antiquated character, and the company's finances are far from being of a robust nature. There is an earnest desire on the part of the directors to bring the fleet up to date, and to place the finances upon a sound basis. One of the proposals brought forward to accomplish this object is founded upon a scheme to dispose of the shipbuilding yard to a new company, in which a Newcastle firm is to have a large interest, although the Austrian Lloyd would control the majority of the shares. The realisation of the project depends upon the completion of the new subsidy agreement pending between the Government and the company, and as the agreement provides for the national construction of the company's new steamers in the future, it is expected that this will be effected by the new company taking over, modernising, and working the Lloyd's yard. In all probability the scheme will be carried into effect at an early date, and Austria-Hungary will be rendered more and more independent of external aid in the construction of both merchant vessels and ships of war.

AUSTRALIAN NAVAL DEFENCE.

THE recent speech of Mr. Playford, Federal Minister for Defence, in which he stated that two directly different plans of defence were placed before him, indicates an open rift in the policy of Australian naval defence which has long existed in secret. Briefly, the Admiralty's view is that no local defence is required, while the Australian technical adviser says that it is essential. The problem is best grasped by means of a simile. Let the question be applied to some condition of everyday life, as, for instance, police protection in an outlying suburb of London. Are the needs of that suburb best met by a special local police force whose duties extend only to the limits of the suburb, or is it better to patrol with members of the general police force in numbers varying with the needs of the occasion? The alternative represents what the Admiralty now does with regard to Australia, and in the ordinary way it is obviously the best policy for everyday use. War, however, is not the everyday condition, so we have to think of our suburb at a time when riots or hooliganism are rampant. In such a case, whatever might be done by the general police force, there would be a local desire for a local force of special constables, which would be necessary or useless according to the ability of the general force to deal with the situation, whilst the local police would be of little or no protection in the case of an organised

attack by the general body of metropolitan hooligans.

Thus far the simile. Translated back into naval facts, we see at once that no local Australian squadron would be able to act unsupported against a serious attack in force by a great naval Power, which would take very good care to employ overwhelming force. The duty of the British Navy would be the obvious one of destroying this fleet before it crossed the equator; it would, indeed, attack it as it issued from harbour. No great attack upon Australia can, therefore, take place unless the British fleet is first accounted for—no slipping away unobserved of big squadrons is possible in these days. There remains, however, the possibility of raids by a single powerful armoured cruiser or by an armed liner bent on doing damage as opportunity served. Big armoured cruisers capable of being detached for such service are few, and the imperial force now maintained upon the station is able to deal with any such raider, whether by destroying or capturing her or by inflicting sufficient damage to make her career no longer one of menace. Finally, we have to consider the armed liner. She, of course, is quite easily destroyed by any warship that can catch her. Even were she fast enough to evade pursuit, the mere fact that she was being followed would make her depredations of small account, and in any case a local defence force seems superfluous. Yet Australia's hankerings after such a force are undoubted. In part, probably, this is due to sentiment, for the rest there is always the idea that the imperial ships "may be ordered elsewhere, leaving Australian shores unprotected." This dread has little or nothing but surface plausibility to warrant it, because one main essential of the British fleet is to be hard on the tracks of an enemy. The idea that British ships might be re-called in order to join in a life-and-death struggle in Europe is also liable to lead to error, but in such a struggle Australia's fate would be in the balance, because it is the British fleet off the hostile harbours that is her surest protection—the bar to any serious attack upon her. At the worst an enemy, if he did do any chance raiding, would have to pay for it at the peace if we won; while if we lost, nothing that Australia could do, save separation from the Mother Country, would save her from being involved in the common ruin.

There is, therefore, no logical argument for local defence. Sentimentally, there is much to be said for it, both as regards interesting Australians in the Navy, and the vital needs of naval power, and also as a recruiting ground for the Imperial fleet. A local fleet belonging to Australia, and manned by Australians, would perhaps serve as some sign manual of the vast invisible Navy upon whose action, thousands of miles away, the safety and integrity of Australia really depends, and ever must depend as long as she is a unit in the Empire, no matter what home force she may raise.

STEAM ENGINES IN THE STREETS.

NOT long since we expressed our certainty that the steam lorry and its congeners, as used in the metropolis, very frequently created a quite preventable nuisance—smoke, steam, and loud noise accompanying their progress. As these heavy machines begin to get out of repair the noise augments, until some thoroughfares are really becoming uninhabitable. The Public Control Committee of the London County Council have at last taken action, and suggest that the President of the Local Government Board should be asked to receive a deputation from the Council to point out the nuisance which is caused by heavy locomotives, and to suggest that fresh legislation should be promoted by his Majesty's Government to deal with the matter. The recommendations to be urged by the deputation are very far from drastic. There are only two out of seven of much importance. The first is that every locomotive shall be fitted with suitable springs, and the second is that licensing authorities shall be empowered to refuse to license any locomotive which is not so constructed as to avoid unnecessary noise or vibration subject to an appeal to a magistrate in case of dispute. Of course, this opens the door for endless litigation. The prime offenders are not the heavy, slow-moving, old-fashioned traction engines, of which a very small number move about in London, but the vans and lorries of modern design. The use of cast iron or steel road wheels ought to be prohibited. When wood wheels are used the noise is greatly diminished. That the nuisance can be abated is proved by the comparatively silent progress of steam vehicles built by certain makers. The question was brought before the Council on Tuesday, and after some discussion it was decided that action should be taken as recommended by the Committee. This means that the Government shall be asked to legalise the by-laws proposed. Two of them we have given, the others refer to the use of bridges, the weights to be carried, and the number of trailers, but they scarcely touch the nuisance side of the problem. If only noise can be kept down, there will be few complaints heard, and we maintain that the desired end can be attained if the builders of this class of vehicles will use their brains and take a little trouble. For once we are heartily in accord with the London County Council, and wish it every success.

THE CRUISER SQUADRON.

THE Cruiser Squadron, which, under the command of Rear-Admiral Prince Louis of Battenberg, has recently been visiting America, has just carried out an excellent run back across the Atlantic. Starting at 1 p.m. on November 20th, three, at any rate, of the vessels—the Drake, Berwick, and Cumberland—arrived at Gibraltar early on Tuesday morning, having maintained an average speed all the way across of 18·6 knots. The Drake, apparently, arrived slightly before the others. In view of this performance it is interesting to note that the Drake is a 14,100-ton vessel, whereas the other two are only of 9800 tons. The Drake and the Cumberland were both fitted with Belleville boilers, while the Berwick has Niclausse. It is a noteworthy fact that the previous last full power sea trials of all three boats produced almost identical results. The Berwick and Cumberland made 24·4 knots and the Drake 24·5 knots. Having regard to the close approximation of the duration of voyage of the three ships, it would seem that the machinery of all must have been kept in a high and equally excellent condition. Of course, the speed of 18·6 is not high when it is considered that all were capable of doing some 5½ knots more. It is when the length of time that this average was kept up is considered that the high rank of the result becomes most evident. It is interesting to find that the Drake was built at Pembroke, and engined by Humphreys and Tennant; that the same firm engined the Berwick, which was built at Beardmore's; and that the Cumberland was built and engined by the London and Glasgow firm. In the class to which the two smaller boats belong, if report be correct, the coal consumption is comparatively high. On the other hand, in the case of the very much heavier Drake, 30,000 indicated horse-power and 24 knots are produced with an average of from 19 to 20 tons in the twenty-four hours. So far no figures are available as to the actual coal consumption on the present voyage. They should be interesting reading. In any case, congratulations are due to every one concerned on the achievement. It certainly forms a useful object-lesson as to what may be expected in time of war. According to present knowledge two other vessels of the squadron were expected to arrive on the afternoon of the day in which the first three reached Gibraltar.

BOROUGH COUNCILS AND THE FACTORY ACTS.

Is a municipal workshop a "factory" within the meaning of the Act? This troublesome question Mr. R. O. B. Lane, K.C., was called upon to decide at the West London Police-court on November 23rd. If such a workshop is within the Act, it is incumbent upon the borough council to conform to the rules and regulations which have to be observed by the occupier of an ordinary factory. In the case before Mr. Lane the workshop in question was occupied by the Borough Council of Kensington, and was used by them for repairing and replacing the tires on cart wheels, and for bending such tires out of straight bars. In these workshops there was a planing machine unfenced, and a factory inspector summoned the Council on this account. The magistrate, in giving his decision, observed that the case was about as near the line as any case could well be. He could not, however, escape from the words of the Act of Parliament, and he held that this workshop was a factory within the meaning of the Act. He expressed his willingness to state a case for the opinion of the High Court. He inflicted but a small fine, first because it appeared that all the borough councils appeared to take the same view as the Kensington Council, and secondly, because the evidence put forward to show that the machine was dangerous, and what kind of guard was necessary, was of the most meagre description. Seeing that the case is likely to go to a higher Court we do not propose to comment at length upon this decision. If it is the fact that borough councils are to be exempt from the observance of the Factory Act, we wholly fail to see why they should be so excused. These Acts were passed with a view to securing safety of life and limb for the workman. Why should the workshops of a local authority be supposed to secure an immunity to the workman which renders enforcement of the factory regulations unnecessary?

THE COAST EROSION AND SEA DEFENCES OF NORTH-WESTERN EUROPE.

M. BONNIN has contributed three articles on the subject of coast erosion to *La Nature* during the course of this year.* In the first he describes the protection works of La Dune D'Helgoland, which recently have been carried out by the German Government; in the second he considers the natural phenomena of coast erosion; and in the third he discusses the theory and practice of sea defence. As the erosion referred to is principally that produced by the North Sea and the English Channel, and as comparisons are made frequently between the coast erosion of the United Kingdom and that of the continental mainland, there is much which is of interest to us, and in which we have common cause. On this account the following abstract is given, supplemented by such observations as may be prompted by a perusal of the French context.

M. Bonnin opens his article, "Erosions des Côtes par la Mer," by a description of the catastrophe which then had just occurred at Cap de la Hève, in which many lives were lost and 700,000 cubic metres of rock was dislodged. The adjacent coast line recedes about two metres per annum, and the erosion is attributed to the friable nature of the clay foundation. The undermining of cliffs, the fall of the overhanging top, and the dispersal of the detritus, are processes which all cliffs undergo. The harder the rock of which they are composed the slower the abrasion; the more friable, the more rapid the destruction. This is exemplified by the onslaught of the Atlantic waves on the granite of Land's End, between which headland and the Scilly Isles about 587 square kilometres of land it is stated have been submerged by the sea. Amongst other examples which may be given are the degradation of the lofty Moher Cliffs, on the west coast of Ireland, in spite of the millstone grit of which they are composed, the formation of arcades in the basalt cliffs of the Isle of Mull, and the destruction of the porphery points of L'Estérel. In all these cases the cleavage of the rocks greatly assists the work of their destruction. The chalk cliffs between the Isle of Wight and South Foreland, like those on the coast of Normandy, between Vire and Calais, are powerless to resist the undermining action of the waves. Similar instances of the yielding of the cliff-line to the encroachment of the sea are furnished at Etretat and at Arrowmanche—Demoiselle de Fontenailles—where the material is friable, at Kodoch—on the Black Sea—where the cliff consists of very loose tertiary schists, and between Bidart and Biarritz, where the cliff consists of Nummulitic limestone.

M. Bonnin estimates that 5,000,000 cubic metres of land is lost every year by erosion on the coast of Normandy between Barfleur and Somme, and 4,500,000 cubic metres every year on the coast of England opposite. It is estimated that Grave Point, the long headland of argillaceous material forming the extremity of the left bank of the Gironde, receded 600 metres between the years 1825 and 1855, and that the Medoc coast receded 350 metres eastwards during the same period. More than 12,000,000f. has since been expended on the erection of sea walls and groynes for the protection of Grave Point. By way of comparison we have the well-known recession of the Holderness and the East Anglian coasts, and the washing away in former times of villages, the remains of which are now lying on the bed of the North Sea. M. Bonnin might have mentioned also the threatened conversion by the sea of Spurn Point into an island, and the large sum of money expended by the English Government on its protection by means of groynes.

On the German coast, too, severe erosion takes place especially on the shores of that large bay into which the Elbe and the Weser empty themselves. There is a continual wasting of the coasts of Mecklenbourg, which consist of boulder clay, the annual rate of the erosion being two metres at Warnemünde. Rapid erosion is noticeable too on the coasts of Schleswig and around the islands of Helgoland, Sylt, Wangenroog, and Norderney. The protection of the Baltic coast and the fixation of the dunes has been undertaken for many years by the German Government at the cost of many millions of francs. (M. Bonnin is a little humorous at our expense on the question of State aid in sea defence work, and he says that one cannot but smile at *l'idée un peu platonique de la création d'une commission royale chargée d'étudier la question.*)

M. Bonnin describes the processes of the shaping and sorting the materials of cliff detritus, the formation of beach falls, the grading of shores, and littoral drift. It suffices to say that his opinions are in accord with those generally held by English engineers. The materials removed from the coast by wave action and other natural forces go to form the obstructions of estuaries, such as those of the Seine and the Thames; the sand-banks, such as those found in the North Sea, and the sand dunes, such as those so skilfully held in position on the Dutch coast.

Having pointed out the dangers to property and navigation which are effected by the sea, M. Bonnin devotes two articles to sea defences, one of which refers entirely to Heligoland and its Dune. Heligoland is of great importance, from a military point of view, to the German Government, as it commands the entrances to the Elbe, the Weser, and the Jade. It is bordered by argillaceous cliffs rising from a thin bed of chalk; and it is subjected to erosion at the rate of about 90 cm. per annum. The prevailing winds are from the north-west, and littoral drift is in a south easterly direction. The German Government has decided to construct a sea wall along the entire western coast of the island. The Dune d'Helgoland is a sandy islet, situated about 1200 m. eastward of Heligoland, of which it formed part until 1720, when the sea broke through the connecting chalk bank. On account of the strategic value of Heligoland,

* *Vide La Nature* of 7th January, 16th September, and 2 at October, 1905.

and because it has been decided to form a harbour for the German warships between the two islands—and, perhaps, partly on account of the popularity of the Dune as a place for sea-bathing—the German Government has already carried out important works for the protection of the Dune. The engineer was M. Franzius, who was responsible for the Weser improvement works. Low fascine groynes have been erected, radiating from the bank, and some of them extending below low-water mark. Transverse groynes are constructed between the principle groynes, and the whole arrangement resembles somewhat a vast spider's web. These groynes vary from 10 m. to 15 m. in width, and are about 1 m. in height, their sides sloping down to the level of the shore, so as to avoid the scour which might be caused by an abrupt check to the currents. It is claimed that by means of these works the sand has accumulated on the foreshore and seawards to such an extent that low-water mark has receded 60 m. at certain points. These fascine groynes, however, have yet to withstand the action of the sea during a winter before they can be pronounced trustworthy and successful.

M. Bonnin speaks highly of the system of groyning which the late Mr. Edward Case originated and applied successfully at Dymchurch and other places. He describes this system very fully; but his description of the construction is for timber. A great amount of Case groyning of timber construction has been badly damaged and rendered inoperative through the attacks of the toredo navalis, and at the present day those who are experienced in constructing Case groynes find it necessary to use reinforced concrete both for the planking and the piles.

High groynes are constructed either of timber, concrete, or masonry. Whatever accumulation they may effect on their windward sides is more than neutralised by the scour which they cause to the leeward. If they adjoin a sea wall they will cause an undermining of the foundations to the leeward. Hastings and many other places afford examples of this destructive action.

M. Bonnin advocates substantial construction and deep foundations for sea walls, on account of the undermining action of the waves. Sea walls require for their protection a heavy beach full and a properly graded foreshore—requirements which can be attained only by the use of groynes. The seaward profiles of sea walls and their construction vary with local conditions. In Holland a very flat slope is used, and the construction is generally basalt or other paving on fascine work on a clay foundation, the toe of the slope being protected by protruding stones. At Grave Point the sea wall is paved, and has enrockments at the toe. At more exposed places, as at Scheveningen and at Havre, concrete, or concrete faced with basalt, or solid masonry, is used, and a curved profile—generally cycloidal—is adopted.

In conclusion, we may emphasise one short paragraph. Translated, it is:—"All carting away of shingle from the shore, for boats' ballast or other industrial purposes, as unfortunately occurs at many seaside places, is a pernicious practice, and one which ought to be prohibited."

OBITUARY.

ALBERT J. PITKIN.

THE death is reported of Mr. Albert J. Pitkin as having taken place at his home in New York City, on November 16th, after an illness of several months, the serious character of which was not appreciated or widely known among his closest friends, and the news of his death was a surprise to all. Of Mr. Pitkin it was said in America that he was of the type of men which the world needs, and can least spare. From the beginning of his career of activity he was associated with the locomotive. He realised the vital relationship between the locomotive and human welfare, and was inspired by the desire to develop and improve it to the utmost. The high position which the Schenectady Locomotive Works has attained among industrial establishments was chiefly the result of Mr. Pitkin's high ideals, and earnest, unceasing efforts. As the managing head of these works he exerted an influence which reached far beyond the locomotive itself. Many improvements in motive power matters and methods originated with him, and he was deeply concerned in an effort to uplift and uphold the locomotive and motive power management. As an argument he often said: "The locomotive earns every dollar brought into the treasuries of railroads. It therefore merits the best attention railroad men can give it."

Mr. Pitkin was born at North Hampton, Ohio, in 1854. At the age of seventeen he entered apprenticeship in the stationary engine works of the Webster, Camp and Lane Machine Company, of Akron, Ohio. He spent a year in the locomotive repair shops of the Cleveland, Akron and Columbus Railroad, after which he entered the drawing-office of the Baldwin Locomotive Works. From this time he gave his attention to locomotive work. After five years at the Baldwin works he became chief draughtsman of the Rhode Island Locomotive Works, and two years later, in 1882, was appointed mechanical engineer of the Schenectady Locomotive works. In two years he became superintendent of the Works. Upon the death of the president, Edward Ellis, Mr. Pitkin was made vice-president and general manager, and from that time developed the commercial, as well as the manufacturing features of the business which gave these works their high standing among the locomotive building companies of the country. Upon the formation of the American Locomotive Company, Mr. Pitkin naturally became its first vice-president, and upon the death of Mr. Callaway, on June 1st, 1904, Mr. Pitkin was made president.

He was a most generous and considerate employer, and was sincerely interested in the welfare of his great army of men.

THE NORTHAMPTON INSTITUTE.—We are informed that Sir William Preece, K.C.B., F.R.S., will distribute the prizes at the annual prize distribution and conversazione of the Northampton Institute, Clerkenwell, E.C., which takes place at 8 p.m. on Friday, the 8th inst.

MOTOR CAR EXHIBITION AT OLYMPIA.

No. II.*

"THE only motor car in which machinery and carriage body do not quarrel" is claimed to be that built by the New Engine Company, of Acton Hill Works, Acton. This car certainly embodies several original features.

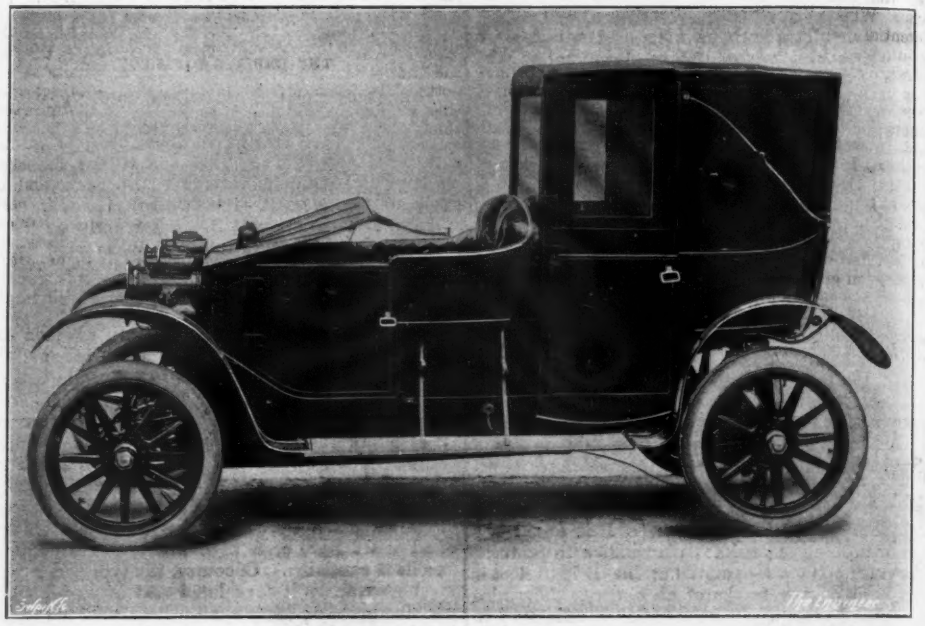


Fig. 14—20 H.P. LANCHESTER PETROL CAR

A horizontal four-cylinder balanced engine with cylinders 4¼in. by 4¼in., is built in transversely under the front seat of the carriage. Practically no portion of the motive mechanism is visible owing to the main frame and body being hung low. The frame is suspended from the axles by plate springs fitted to each corner, the front springs being secured on top and the rear springs beneath the axle. Behind the engine is the fly-wheel, and behind this again an epicycle change-speed gear, giving two forward and one reverse speeds. The gearing and the motor are secured to an independent framework. From the change-speed gear the motion is transmitted to a "live" rear axle by a central propeller shaft with universal joints and worm gearing. The engine develops about 30 brake horse-power at its normal speed of 1250 revolutions per minute, and the car is either geared to run at 27 or 35 miles per hour, according to requirements. Each piston is fed with oil direct from a large lubricator on the dashboard, but the other moving parts are lubricated through the hollow four-throw crank shaft by means of a pump.

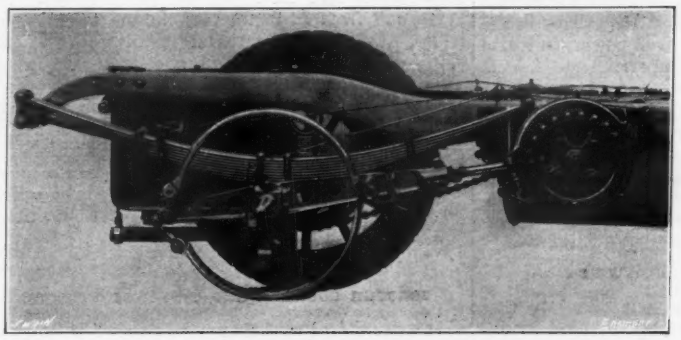


Fig. 15—BROTHERHOOD-CROCKER RADIUS ROD

The Napier cars shown by Messrs. S. F. Edge, Limited, have vertical six-cylinder petrol motors of 40 horse-power. The cylinders are cast in pairs and bolted to an aluminium crank case. The inlet and exhaust valves are all operated from one cam shaft, the former by tappet rods and levers and the exhaust valves by plungers. The carburetter combined with the Napier hydraulic air regulator is provided with a cylindrical throttle valve actuated by the governor. The governor is attached to an extension of the water-circulating pump spindle. This pump is driven by a chain from the crank shaft. To ensure synchronous firing of the charge in all the cylinders a special distributor coil, together with high and low-tension circuit distributor, are provided. These distributors are driven from a vertical spindle, taking its motion from the engine cam shaft. The advantage claimed for this system is that in only having one coil all errors that would occur in firing by employing multiple coils or tappet rods and springs are eliminated, and the distributors being mechanically driven, the firing must be, and is, absolutely correct, at no matter what speed the engine runs.

Whether there is a sufficient demand for cars fitted with six-cylinder engines it is not for us to inquire, but the advantages claimed for motors with so many units, as compared with four-cylinder engines, are scarcely sufficient to justify their use; while the disadvantages in the extra length of wheel-base involved, and the cost of fuel, are considerable.

While retaining the leading features of last year's cars, with which our readers are familiar, the Brotherhood-Crocker Motor Company has introduced one or two improvements in details in the 1906 car which are worth mention. Hoffman ball bearings, hitherto used on the road wheels, are now fitted in the gear-box and cross-shaft—Fig. 17. A new type of radius rod—Fig 15—working truly round the centres of the sprocket shaft and rear axle respectively, always keeps the chain centres equidistant. This is also arranged to carry the bands for the rear brakes, always assuring the brake bands being true to the brake drums under all conditions. The brake drums on the rear wheels are now fitted between the sprocket ring and the spokes, being made in one with a steel driving ring, built up in the road wheel, making this part more compact, lighter, and stronger. A pawl and rack arrangement is provided on the near side road wheel to prevent the car running backwards downhill. The pawl is carried on a bracket from the axle, and engages in teeth solid with and inside the brake drum—Fig. 16. The pawl is either dropped or raised by a small lever on the change-speed lever quadrant, and the latter is so arranged that when the change-speed lever is in the reverse position the pawl is automatically held free from this rack, so that it is impossible to drive the car on the reverse gear when the pawl is locking the road wheel. On a new 40 horse-power chassis made by this firm, the general features of the 20 horse-power car are retained, but a departure has been made in the clutch. This is of the disc pattern, somewhat on the lines of that designed by Professor Hele-Shaw.

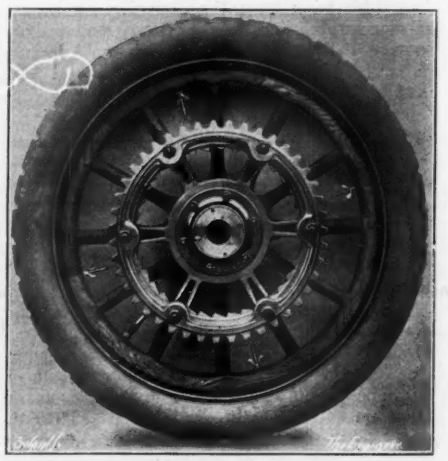


Fig. 16—ROAD WHEEL SHOWING INTERNAL RACK

There of the most prominent British firms who have become converts, partially or altogether, from the horizontal to the vertical type of petrol engine, are the Arrol-Johnston Company, of Paisley; the Lanchester

* No. I appeared November 24th.

Company, Birmingham; and the Wolseley Company, Birmingham. The Arrol-Johnston Company, like the last-named firm, is keeping to the horizontal motor for the low-powered cars, but in the higher-powered vehicles and omnibuses a four-cylinder vertical engine, capable of developing 24-30 horse-power, is fitted. The cylinders are 4¼in. by 5in., and two types of ignition apparatus are provided, low-tension magneto and batteries. The gear-box gives four speeds, and the power is transmitted to the differential gear on the live rear axle by means of a cardan shaft. When applied to omnibuses, however, the differential shaft is distinct from the back axle. It forms a countershaft from which motion is transmitted to the road wheels by side chains. The Lanchester Company is giving up the horizontal engine altogether; the 20 horse-power vertical engine, Fig. 18, now fitted has cylinders 4in. diameter by 3in. stroke, and projects up through the foot-board. It is encased by a bonnet, by removing which the valves can be reached. The exhaust and induction valves are fitted on either side of the engine and operated mechanically from cam shafts. The engine is governed on the throttle, acting separately on each cylinder. The cooling system acts upon the thermo-syphon principle. The familiar wick carburetter has been retained. The transmission gives a direct drive on the high gear, through a metal-to-metal lubricated clutch. The well-known epicyclic gear and worm drive are still features of the Lanchester car.

Apropos of clutches, the Sparks-Boothby Hydraulic Clutch Company, Limited, 38, Parliament-street, Westminster, exhibited an ingenious device in which a quantity of oil is enclosed between the driving and the driven members, and is the only medium through which the power is transmitted. The slip of the clutch is dependent on the resistance offered to the circulation of oil, and not on contact friction. It consists of two chief parts, A C. There is an annular chamber formed at the rim of fly-wheel A, which is the driving member, and the pallets E which fit the annular chamber act as pistons. A stop D forms a partition in the annulus, and a valve Z is

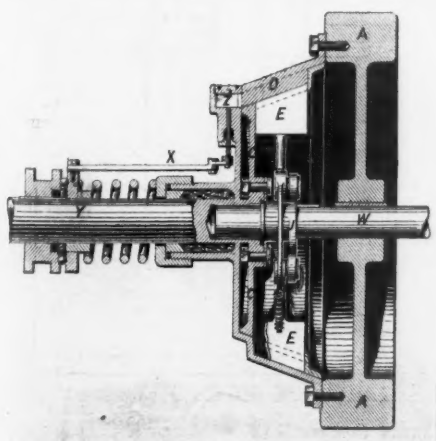


Fig. 19—THE SPARKS-BOOTHBY CLUTCH

constructed to allow the oil to circulate round this stop. This valve is controlled by the movement of the clutch pedal. The whole of the fly-wheel casing is filled with oil, including the annulus. Upon the driving member A being rotated, the driven member C must, then, also rotate, because the oil which fills the annulus cannot pass either the pallet E or the stop D until the valve Z is opened by depressing the foot pedals. When this valve is opened the oil is allowed to circulate freely, and no power is transmitted. As the pallets E approach the stop D they are automatically and alternatively removed by the cam J from the circular path of the annulus, thus avoiding collision with the stop D. The chief objection to this ingenious clutch appears to be the difficulty of keeping it perfectly oil tight.

The marine section of the Exhibition was fairly representative of the motor boat industry, but features of novelty were few. John I. Thornycroft and Co., Limited, however, showed a two-cylinder marine engine designed for suction producer gas. The Parsons Motor Company, Limited, Southampton, exhibited an internal combustion engine for marine work, which is designed to work with either petrol or paraffin—or, perhaps, it is more correct to say that the engine works on both. That is, petrol need be used for starting only. For paraffin no external vaporiser is needed, and the carburetter is of any ordinary pattern used for spirit. The paraffin is vaporised in the engine valve chamber in a novel manner. The valves are combined, and the exhaust valve is seated upon the hollow tubular inlet valve. The exhaust passing through the latter heats it up, and emerges through ports at the bottom of the valve. The incoming charge impinges upon this hot valve and is vaporised. We are informed that this arrangement acts equally well with either fuel. In the matter of boat propulsion the Parsons Company use a clutch and a feathering or reversible blade propeller, which gives the advantage of variable pitch, and by releasing the clutch, obviates undue stress on the parts when reversing under power. In all models of the Parsons engine, a universal joint is provided for the connection to the propeller shaft, thus allowing a vertical engine with a raking shaft. The engines are made with one, two, or four cylinders, and the workmanship leaves nothing to be desired.

The Exhibition closed last Saturday night, and has been remarkably successful from all points of view. The visitors numbered over 155,500, and the estimates of the value of cars sold is beyond the most sanguine anticipations.

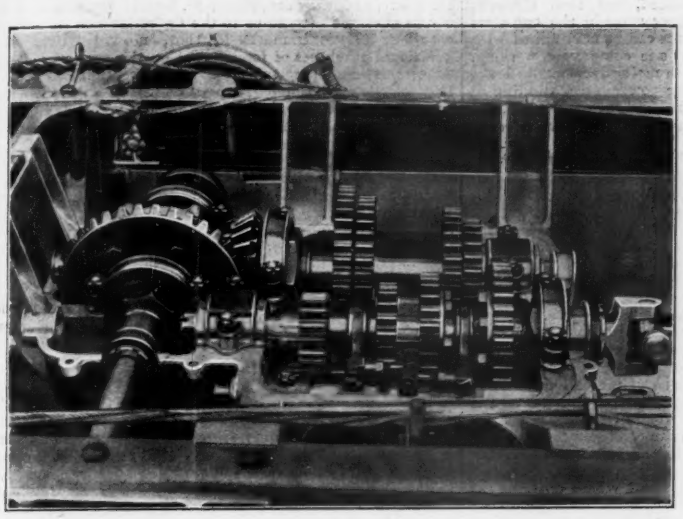


Fig. 17—BROTHERHOOD-CROCKER GEAR CASE

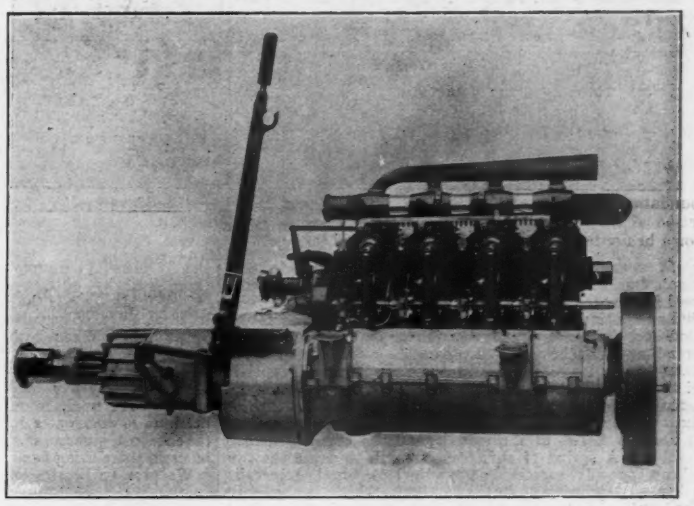


Fig. 18—LANCHESTER FOUR-CYLINDER VERTICAL ENGINE

FORTHCOMING MEETINGS.

No. IV.

GLASGOW ENGINEERING SOCIETIES.

THE Institution of Engineers and Shipbuilders in Scotland, whose president, Mr. James Gilchrist, gave his opening address on November 21st, has already had three meetings this session, the last having been held on the 22nd ult., when the valuable paper read at the previous meeting by Mr. E. M. Speakman, on "The Determination of the Principal Dimensions of the Steam Turbine with Special Reference to Marine Work," was shortly discussed. The paper has been reproduced *in extenso* in our columns. Other five meetings will be held, on the third Tuesday of each month, at which the following papers, probably in the order named, will be read:—"Steam Turbines," by Mr. R. M. Neilson, Manchester; "Notes on Some Common Errors in the Use of Electric Motors for Machine Driving," by Mr. W. A. Ker; "The Application of Calculating Charts to Slide-valve Design," by Mr. Wm. J. Goudie, B.Sc.; "On Steamship Speed and Power Reference Tables," by Chas. F. A. Fyfe, Belfast; "On Equimomental Systems and their Use in Applied Mechanics," by Mr. R. F. Muirhead, D.Sc.; "On Refuse Destructors," by Mr. H. Norman Leask, of Messrs. Heenan and Froude.

The opening meeting of the students' section of the Institution was held on November 7th, when the presidential address was given by Mr. E. Hall-Brown. At the forthcoming meeting on December 5th a lecture will be given by Mr. Robert Lang on "Modern Lathes and their Capabilities." On February 6th a paper will be read on "Strength Calculations for Ships," Mr. Matthew W. Halley; on February 17th, on "Fuel Combustion in Boilers," by Mr. Robert Baillie; on January 10th, "The Testing of Material," by Mr. James Craig; and on May 8th, "The General Problem of Stability with Reference to Submarines," by J. C. Johnstone, B.Sc.

The Institution of Civil Engineers—Glasgow Association of Students—was addressed by the president, Mr. Donald A. Matheson, on the 20th November, his subject being the training of young civil engineers, and on December 4th a paper will be read on "Methods of Constructing Main Sewers under Railways on Glasgow Main Drainage Works," prepared jointly by Mr. A. L. Houston and Mr. R. M. Morton. On December 18th, "Hebburn Graving Docks" will be the subject dealt with by R. S. G. Fowler, B.A. On January 8th, "Sewage Purification Works for Small Towns," by Mr. James Thomson. On January 22nd, "Aberdeen Railway Widening," by Mr. W. A. Kemp. On February 5th, "Notes on Earthwork in the Construction of Railways," by Mr. J. W. F. Gardner. On February 19th, "Electrical Signalling," by Mr. F. Sykes. On March 5th, "Clyde Valley Electrical Power Works," by Mr. H. A. Barnett, and on March 19th, "Tramways," by Jas. More, jun., M. Inst. C.E.

Glasgow University Engineering Society held its opening meeting in the lecture theatre of the James Watt engineering laboratories of the University on November 2nd, when a lecture was delivered by Mr. Arthur Guistone, of Sir W. G. Armstrong, Whitworth and Company, Limited, Newcastle-on-Tyne, on "Lake Baikal and its Connection with the Great Siberian Railway." On November 23rd a paper was given by Mr. H. A. Mavor on "The Art of Approximation." Mr. G. T. Beilby, F.I.C., gives his presidential address on January 11th, and at the following meeting on February 1st J. Bruhn, D.Sc., will read a paper on "The Influence of the General Arrangement of Ships on the Structural Design." At the concluding meeting on February 22nd a paper on "Mining in Australia" will be read by Professor J. W. Gregory, D.Sc., F.R.S.

The Glasgow Technical College Scientific Society, which meets in the new College-buildings, George-street, opened the present session on 21st October, when a lecture was given on "The Training and Work of Engineers in some of their Wider Aspects," by Henry Dyer, D.Sc. On November 4th a paper on "Electric Power Plant Design" was read by Philip D. Ionides, and on November 18th one by A. Marshall Downie, B.Sc., on "The Commercial Efficiency of Prime Movers." There will be ten other meetings, at which papers on various subjects will be read. On December 2nd, one on "Metallography" will be given by James Muir, D.Sc., M.A. On December 16th Wm. D. Hamilton, consulting engineer to the Glasgow Corporation Sewage Committee, will deal with "The Economy of Power Production—Relative Merits of Gas and Steam Engines for various Purposes." On January 20th a paper will be read on "Deep Mine Pumping" by Mr. John Hogg; on January 27th, "Cylinder Ratios," by James Andrews, M.I.N.A.; on February 3rd, "Notes on Tool-room Organisation and Practice," by Mr. George Blair, B.Sc.; on February 17th, "The Inglis Patent Boiler," by Mr. Gardner Inglis; on March 3rd, "Portable Electric Tools and their Application to Industrial Purposes," by Mr. Andrew Stewart; and on March 17th, "Metals used for Bearings of Shafting and Lubrication of Same," by Mr. James Murdoch.

The West of Scotland Iron and Steel Institute commenced its present session on October 20th in the Institute Rooms, Bath-street, when the president, Mr. Andrew Lamberton, gave an address, and thereafter a paper was read by Mr. A. Campion on "Notes on Tensile Testing." On November 17th a lecture on "Some Notes on a Visit to the United States and Canada," illustrated by lantern slides, was given by Mr. P. M. Cunningham. On December 8th a paper will be read on "Cast Iron in the Foundry," by Mr. Percy Longmuir; on January 19th a paper on "The Talbot Process and its Benefits in Steel Making," by Mr. G. A. Wilson; on February 16th a paper by Professor F. W. Burstall, on "Some Future Developments of Heat Engines," and the concluding paper on March 16th will be by Mr. M. L. Simpson on "The Economic Use of Exhaust Steam for Generating Electricity."

The Glasgow and West of Scotland Foremen Engineers' and Ironworkers' Association also hold their meetings in the Institution Rooms, Bath-street, Glasgow, and was addressed by the president, Mr. John Hamilton, on October 14th. On November 11th a full meeting listened to a very elaborate and well illustrated paper by Mr. J. M. Gledhill on "The Manufacture and Practical Use of High-Speed Steel." On December 9th a paper will be read on "Lubrication," by Mr. Archibald Cree; on January 13th, on "Oil Motor Launches," by Mr. John W. Sothern; and on February 10th on "Producer Gas Plant," by Mr. F. J. Rowan.

In addition to the forthcoming proceedings of the various engineering societies in Glasgow and throughout the West of Scotland, a number of separate lectures on questions of present-day engineering interest are to be delivered by well-known authorities. One of the lectures of the course arranged by the Glasgow Lecture Association is on "Submarine Navigation," by Sir William H. White, K.C.B., to be delivered on December 11th. The same gentleman is to deliver a lecture entitled "Submarines" before the usually crowded and representative audience brought together by the Greenock Philosophical Society, in the James Watt Institute, Greenock. The James Watt "Anniversary Lecture" itself, to be given on January 19th, is to be on "Marine Propulsion," by Mr. Sydney W. Barnaby, London.

H.M. Office of Works announces that, subject to certain conditions, which will be strictly enforced, electric carriages will be exempt from the rule prohibiting motor carriages from entering Hyde Park between the hours of 4 p.m. and 7 p.m. during the months of May, June, and July. There is no intention, however, of admitting motor cars other than electric cars to the park during the prohibited hours.

A WAGES CALCULATING MACHINE.

WE have recently had brought to our notice a new calculating machine designed and constructed by Messrs. John Davis and Son, of All Saints' Works, Derby, which embodies several interesting features. The design is free from small and intricate pieces of mechanism which are generally a prolific source of trouble. The calculating machine is introduced to supersede the ordinary method of determining the proportion of the total balance money due to a number of men sharing

THE CALCULATING MACHINE

profit on a contract, the division being proportional to each man's fixed daily or weekly money rate. Not only can it be used in the case of piecework, but it can also be used for finding the time allowance that is to be added to the actual time occupied on any particular job in places in which the premium system has been adopted.

An illustration of the apparatus is given above. It consists of two large wheels, with broad, flat faces, mounted on the same spindle. The spindle is carried at each end in bearings fixed to the wooden supporting stand. One of the two wheels is securely keyed to the spindle, and the other is free to revolve. A spring of sufficient strength to cause the two wheels to revolve together, presses the loose wheel against the other. By pressing down the foot lever, which is shown in the illustration, the pressure of the spring against the wheel is released, thus allowing the two wheels to be turned independently. This is necessary when setting the apparatus. Two cards or scales are attached to the rims of the wheels. These cards are of two kinds, a "wages" and a "balance" scale. The former is placed upon the left-hand wheel, and the latter on the right-hand wheel. The divisions of the scale are marked from pennies up to one pound; from one pound to three pounds each division represents twopence. It is claimed that the balances within these ranges can be read with accuracy to one halfpenny. From three pounds ten shillings to ten pounds each division represents sixpence. From ten pounds to twenty pounds the scale is divided into shillings, and readings of sixpence can easily be made. Results at present can only be obtained for sums up to £20. But if dealing with larger sums than this, they can be divided into some convenient multiple of twenty, and multiplied accordingly.

The machine is set in a similar manner to a slide rule. Near the operator's hand there is a small indicator or pointer which is movable, so that when one amount has been found, this pointer can be put in position and the amount on the right-hand wheel brought to it. The machine is very easily operated, as will be seen from the following example:—Supposing the combined wages of a number of workmen is £20, and they are engaged upon contract work valued at £30. Then the balance £10 has to be divided between the men, in the proportion of their wages. In order to do this the pointer is turned to the £20 on the wages scale, and the £10 division on the other wheel is brought opposite the pointer. The foot is taken off the treadle and the two wheels can then be turned together if necessary. The proportion of the £10 due to each man is then read off on the balance scale opposite to the man's ordinary weekly wage on the wages scale. When dealing with the premium system it is necessary to read hours in place of shillings, and five minutes in place of a penny. The makers, however, recommend the use of a rather smaller machine with special scales when treating the premium system.

A NEW COLD STORAGE PLANT.

A LARGE new building which is to be used as a cold storage depôt and distribution warehouse has recently been completed for Messrs. Aplin and Barrett and the Western Counties Creameries, Limited, of 33, Park-road, Battersea. The work has been carried out under the supervision of Mr. Philip Dawe, Assoc. M. Inst. C.E., of Deansgate, Manchester. We do not propose to describe the whole building, but only that portion which is used for cold storage, together with the machinery.

There are two large cold storage rooms, one above the other, each of about 22,000 cubic feet capacity. The temperature is to be maintained in these stores at about 18 deg. Fah. The insulation material for the walls and floors is formed of two thicknesses of 1in. boards 9in. apart, nailed on either side of joists or studs, as the case may be. Between them there is placed some Willesden paper, and the remaining space is filled in with flake charcoal.

The refrigerating plant has been supplied by the Haslam Foundry and Engineering Company, Limited, of Derby. Anhydrous ammonia is used as the refrigerating agent. There are two compressors directly coupled to electric motors. The compressors are of the horizontal double-acting type, with cylinders 9½in. diameter, with a stroke of 15in., the speed varying from 66 to 90 revolutions per minute, depending upon the required output. Preference is given to running at the low speed for a long time, rather than working the compressors at a high speed for a short time. For, under the latter condition, owing to the longer period of time the machine is not at work, the cold store would have to be reduced to a much lower temperature while the machine was running than it would be if the working of the plant were extended over a greator number of hours per day. The temperature, indeed, would possibly be low enough injuriously to affect the goods stored. With regard to the ice-making capacity of the plant, it is equivalent to 8½ tons of ice in twenty-four hours. The arrangement of the valves of the refrigerating plant differs slightly from that usually adopted. They are so designed that one end of the cylinder can be worked on to one of the cooling batteries—to be described later on—and the other end on the second battery. By this means it is claimed that a great variation in temperature can be obtained, and that different temperatures in the two store rooms can be maintained with only one compressor working. Each motor develops 30 brake horse-power when running at 90 revolutions per minute, and it is said that their efficiency is 86 per cent. They are eight-polar compound-wound variable-speed motors. The voltage is 460. Each motor is fitted with a field regulator for varying the speed of the machines. The spider of the armature is bolted direct on to the fly-wheel of the compressor, thus all the driving is taken through the key of the fly-wheel.

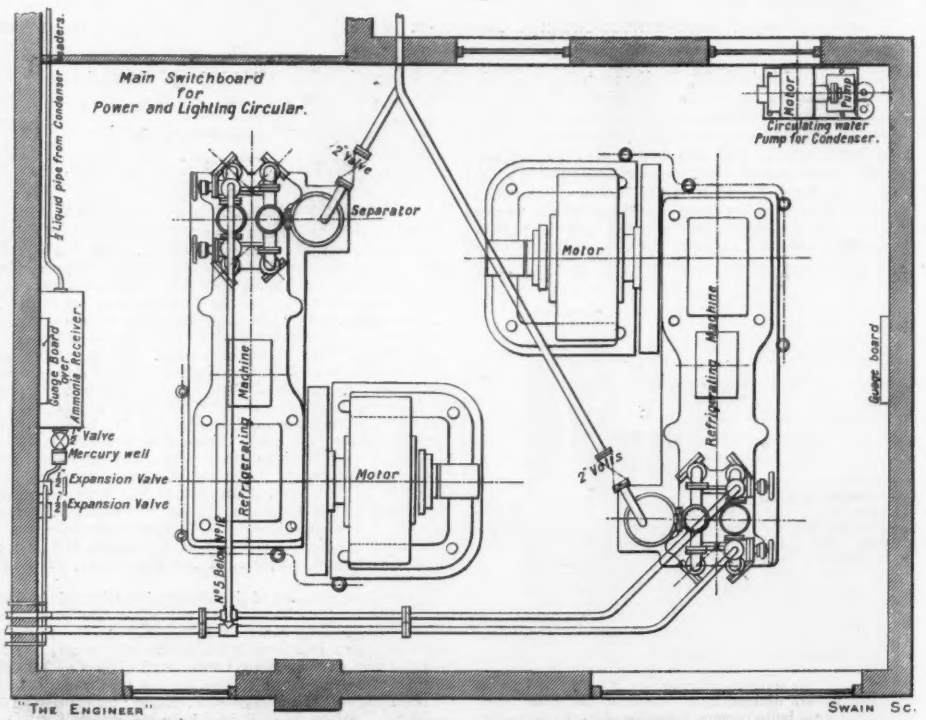
The condenser is of the ordinary evaporative type, arranged in three nests. The valves are designed so that any nest can be cut off. When both compressors are working it is necessary to supply water from the dock—the works are on the banks of the Thames—by means of a small centrifugal pump driven by a variable speed motor. The water, after having been used, is returned to the dock. With one machine at work water delivered from a reservoir is sufficient for condensing purposes. Either town's or river water may be used, there being facilities for employing either.

We give an illustration of the room which contains the compressors and motors. It will hardly be necessary to draw attention to the compactness of the plant. The air circulation system has been adopted. Air that has been reduced in temperature by passing through a cooler is circulated by means of fans through air ducts, which deliver the air into the rooms which it is desired to keep cool. The ducts are situated near the top of the rooms.

There are two air coolers. Each consists of a series of pairs of corrugated plates placed vertically and close together. Down each side of the series is a row of ammonia expansion pipes. Between each pair of corrugated plates is allowed to flow a stream of brine, which is cooled as it descends, and between these corrugated plates is also forced the air to be cooled. The coolers stand in a brine tank, in which some of the ammonia pipes are immersed, so the brine, even before being pumped up into small tanks at the top of the coolers, has already been robbed of some of its heat.

There are two sets of two brine pumps, each pair being connected, one at each end, to a British Thomson-Houston 5 horse-power semi-enclosed motor. One set of pumps is sufficient for each cooler. Air is circulated through each battery by means of two 18in. Blackman fans running at 450 revolutions per minute. The fans are driven by belting from the couplings of the motors used for working the brine pumps, the couplings acting as a small pulley, and both fans can be driven by either motor. The air ducts are so arranged that either battery of coolers can be worked on to either store. Also, if it is required rapidly to reduce the temperature, then both batteries can be worked on to one store.

The building is well lighted throughout, mostly by incandescent lamps, although there are several enclosed arc lamps. The latter, however, are not used in the cold storage rooms. The lighting is on the 460 volts three-wire system, screwed steel conduits being used, through which the conductors are pushed. At the ends of all lengths of conduit, suitable insulating bushes are employed in order to safeguard the insulation.



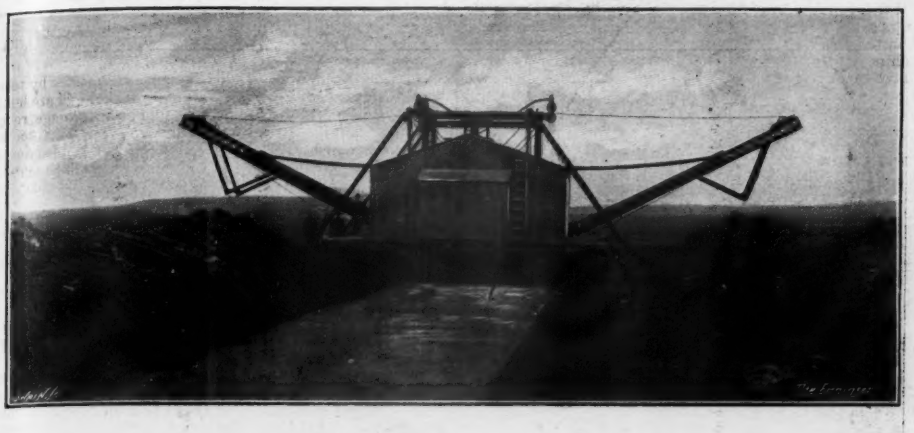
ARRANGEMENT OF MOTOR-DRIVEN COMPRESSORS

THREATENED GERMAN COAL MINERS' STRIKE.

THE coal trade of the great industrial west of Germany, which was paralysed at the beginning of the present year by a miners' strike of unprecedented dimensions, is now threatened with fresh labour troubles, as a result of the existence of a number of alleged grievances, which are claimed by the men to have arisen in recent months, owing to the last strike and the effects of the subsequent amendment of the mining laws. As a consequence of the cessation of work in January and February last, the exporters of British coal gained approximately 2,000,000 tons in increased exports to Germany, and they are, therefore, largely interested in the course of events proceeding in the Fatherland on the present occasion. It is remarkable that, notwithstanding the additional purchases of foreign coal on the part of German consumers, and particularly by the iron and steelworks in that country, in the early part of this year, it has been possible for the Teutonic coalowners, as a whole, not only to recover from the considerable reduction of 4,000,000 tons in the production of coal which had occurred down to the end of March, but also to exhibit an advance over the corresponding period of last year. This point is illustrated by a reference to the official returns, which show that for the first ten months of the current year the output of pit coal amounted, in round figures, to 99,950,000 tons, as compared with 99,270,000 tons in the equivalent term of 1904, or an increase of 680,000 tons for the ten months of 1905. In fact, the production of pit coal, to say nothing of that of coke, lignite, and briquettes, has been forced as much as possible, in order to meet the enormous demands of the iron and steel and other trades, and with a view to the replacement of the large stocks which were in existence on the outbreak of the strike in January last, but which were disposed of during the strife of that period. The production of pit coal would have been considerably greater in the ten months, had it not been for the dearth of railway trucks in the west of Germany, which exceeded the equivalent of 40,000 tons of coal daily on several occasions in the past two months, and which compelled the coalowners to introduce short time and idle shifts.

The complaints of the coalminers at present do not relate, strange to say, to the amount of their wages, which, according to the official report of the Coalowners' Association for 1904, averaged less than twenty-four shillings per week in the Dortmund district, where the pay is higher than in any other part of Germany, not excepting the Government miner. When the miners resumed work in the course of February and March last they did so because the Government promised at once to initiate legislation with a view to improving the condition of the men. As finally carried, the amending Act has done little for the miners, if they are not in a worse position than was the case previously. Practically all that the fresh legislation has done for the miners has been to empower them to appoint a committee at each pit to discuss labour questions with the managers, while the obligation has been placed upon the coalowners to pay for the particular proportion of clean coal found in tubs containing an admixture of coal, stone, and dross, instead of not paying for any coal whatever brought forward in the dross tubs under the former *régime*. It is, however, now

THE JACOBS EXCAVATING MACHINE



alleged by the men that the latter obligation is being nullified by the imposition of fines, and that the workmen committees about to be appointed will be of no value, because it will only be possible, owing to the action of the coalowners, for those who find favour with the representatives of the latter to be elected so as to form the committees. But these are minor grievances as compared with a number of others, some of which owe their origin to the fresh working regulations made under the new Act, and which, the miners declare, are compelling some of them to work longer hours, and many others to work overtime under circumstances which are not permitted by law. In addition to these complaints, the miners say that hundreds of men have been refused employment owing to their attitude on the occasion of the last strike, whilst the system of transfer certificates has been introduced at a number of mines, whereby it is impossible for men leaving one pit to find employment at another without the production of a certificate, which they are unable to do, because such cards are withheld by the mine managers in order to prevent changes in the staff of coalminers.

The Coalowners' Association have issued a definite contradiction of the charges of contraventions of the new Act, the reply having been apparently prompted by the fact that the representatives of the miners have presented petitions to the Minister of Commerce and the Imperial Chancellor, setting forth point by point the instances where they consider the coalowners are infringing the Act. But there has been no official denial of the serious charge that the miners are being tied down to work at certain pits by reason of the existence of transfer certificates which are not issued, that their liberty of action in this respect is thereby destroyed, and that employment is refused them at other pits. Indeed, the petitions to the Government Ministers have already resulted in the Coalowners' Association recommending the pits concerned to abolish the system of limiting changes in the staffs of the miners, but whether this suggestion is acted upon or not, it does not appear that it specifically refers to the method of transfer certificates. The Minister of Commerce, on behalf of himself and the Imperial Chancellor, has informed the miners that as they have now placed their case before the Royal Mining Board of Dortmund, it would not be advisable for him to anticipate the decision of the Board. It seems probable that in the event of the State Mining Board not being able to secure the redress of some of the grievances put forward by the men, the latter may go on strike. They are more united than was the case last January, and are in all probability in possession of larger funds, owing to the doubling of the contributions several months ago, but neither the coalowners nor consumers have on hand stocks of the large extent which prevailed early this year.

THE EXPANSION PNEUMATIC FIRE ALARM.—On Tuesday afternoon the Automatic Sprinkler Syndicate, Limited, of 66, Hatton-garden, London, gave a series of tests with one of its fire-detecting and attacking instruments which has recently been installed in the works of the London Essence Company, of George-street, Camberwell-green, S.E. The tests were carried out both in closed rooms and also in an open shed, the fire being formed of wicker baskets and wood shavings soaked in paraffin. In each case the alarm was given in about 25 seconds, and the sprinkler came into action within one minute, and the fire in each case extinguished. The system consists in having small water pipes rigidly suspended a short distance from the ceiling fitted with sprinklers. The pipes are in communication with the mains through a large water valve. The valve only allows the water to enter the piping when there is a fire. This action will be explained later. The installation comprises a system of seamless copper tubing of about $\frac{3}{4}$in. diameter carried throughout the building near the ceiling. This tubing contains air compressed to about 40 lb. per square inch by means of a hand pump. At intervals of from 6ft. to 10ft.—sometimes greater distances are decided upon—detectors are fitted which consist of small glass bulbs forming frangible points in the tubing. These glass bulbs are placed vertically and are embraced by the fork of a weighted lever. The weighted lever is supported by a stretched piece of copper wire lightly held in a clip. When expansion of the wire takes place on account of the heat of the fire the clip is released from the wire, and the weight drops and breaks the glass bulb. This allows the compressed air to escape. It is said that a rise in temperature of 28 deg. Fah. is sufficient to make the weight drop. There is also a series of iron tubes of larger diameter running throughout the building in a similar manner to the copper tubing. This series of tubing is fitted with the automatic sprinklers which work similarly to the "detector." The sprinklers are more numerous than the "detectors," but the number depends upon requirements. Water valves are placed in the mains, and are constructed so that the air pressure in the small tubing prevents the water from entering the larger pipes. Should a fire occur, and, consequently, one of the "detector" glasses be broken, this pressure is released. The valves are at once opened, the water fills the iron tubes and passes out through those sprinklers that have been put in action by the heat of the fire. Should the pressure drop to zero the word "fire" is exposed on a dial, and an electric gong rings, the alarm being given both locally and to the fire-station. Back-pressure valves are used to prevent all the indicators dropping to zero when the pressure is released in one section.

CANAL EXCAVATING MACHINE.

THE excavating machine shown in the accompanying illustration is a new American machine built for cutting irrigation and drainage canals. Its special feature distinguishing it from other excavating machines is that the bucket moves transversely across the canal, and cuts to any desired cross section. The machine is mounted on a bridge or frame spanning the canal, and supported by wheels running on rails laid upon the banks. At each end is a jib, and beneath the bed of the machine is a steel frame shaped to the required cross section. The buckets travel in opposite directions, cutting to the required section of the canal, and delivering the material either into wagons, or upon the ground, the machine is self-propelling, and has a winding engine of about 20 horse-power. It is built by the Jacobs Excavator Company, of Amboy, U.S.A. The machine illustrated is at work on a system of drainage canals, and is adjusted for a bottom width of 6ft., a depth of 8$\frac{1}{2}$ft., and side slopes of 1$\frac{1}{2}$ to 1. It can be adjusted to any slope or width up to a top width of 33ft. The buckets make a cut 4ft. wide at each stroke, and their feed is controlled by four screws, which are driven from the engine by chain belts. While one bucket is travelling up the runway, and emptying its load, the guide frame is lowered by the screws, so that the returning bucket takes a full cut. Some of the machines have cantilever runways for carrying the buckets to a longer distance from the canal.

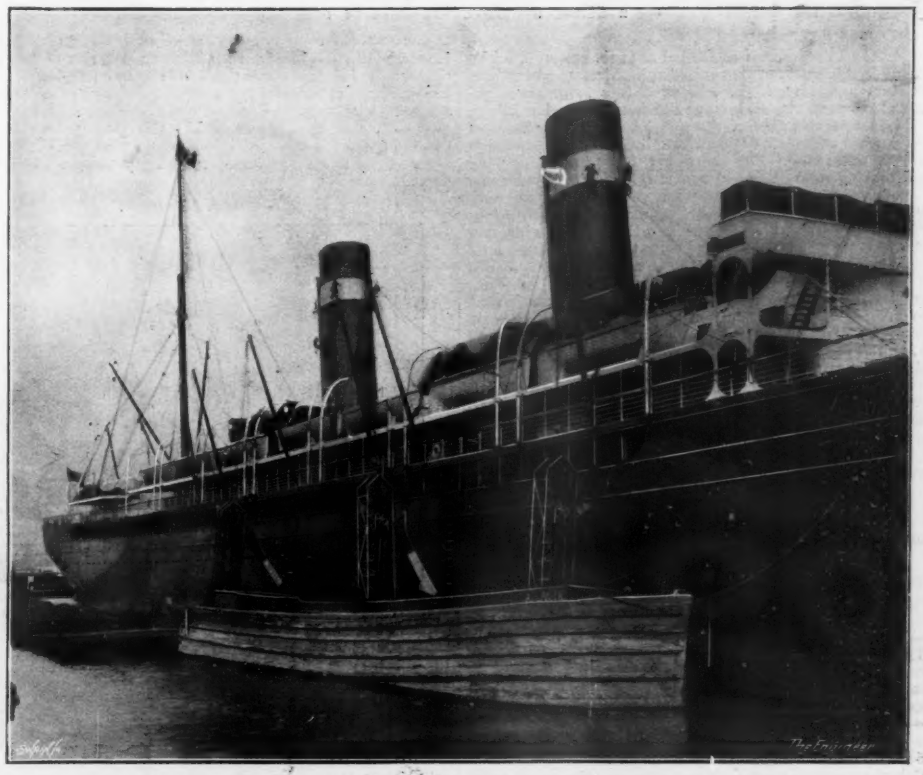
MACHINE FOR COALING STEAMERS.

AT many American ports, including New York, bunker coal is delivered alongside of steamers in large open barges of 300 to 600 tons capacity, and is handled in buckets by a steam winch and jib on the barge, the coal being discharged through shoots into bunker ports in the side of the steamer. The buckets or tubs are of 500 lb. to 650 lb. capacity, and the average delivery is from 15 to 20 tons per hour at each bunker port. The process is slow and dirty, and as large steamers carry from 1000 to 4000 tons of coal, the matter of coaling rapidly is often an annoying problem to the company's ship and shore officers.

The American Line, at New York, has recently adopted the De Mayo coaling system, which can deliver from 60 to 100 tons per hour at each bunker port, and is usually fitted to three or four ports at once. In coaling the company's large and fast steamers—such as the New York, Philadelphia, St. Paul, and St. Louis—the machines have handled 60 tons an hour for sixteen hours at each port. Thus, the time of coaling has been reduced from thirty or thirty-six hours by the old method to sixteen hours by the new method. As a matter of fact, the machines could deliver the coal much faster than this if they were delivering into a space where it could be received more rapidly. The accompanying illustration represents a barge with three De Mayo machines at work. A light steel frame carries endless chains, to which are attached twenty-nine steel buckets of one cubic foot capacity. The frame is 3ft. square and 30ft. high, and is suspended from a hoisting jib stepped in a socket on the ship's side and supported by guy lines. With the machine in position it is lowered until the buckets enter the coal, being lowered as required, while the coal is fed to the buckets by a trimmer. Only two men are required to each machine, and four men can readily erect and shift the machine. An 8 horse-power electric motor in the head of the frame drives the endless chain and takes its current from a connection with the steamer's electric distribution system. The buckets discharge the coal into the head of an inclined shoot, the bottom of which has a shoe entering the bunker port, where it has, of course, to be trimmed by hand. In the illustration the frames are shown uncovered, but in practice they are covered with a canvas or tarpaulin jacket, thus preventing the blowing about of coal dust. The total weight of each machine is a little under two tons.

The common method of handling coal by bringing it alongside in barges, hoisting it in tubs, and dumping it through ports in the ship's sides, has given considerable trouble in coaling the great Pacific twin-screw steamers of the Great Northern Line at the port of Seattle, U.S.A. These ships are of 20,700 tons register, 28,000 tons capacity, with a length of 630ft., beam 73$\frac{1}{2}$ft., and 56ft. moulded depth. There are about eight coal ports on the 'tween decks on each side. The best coaling performance is 300 tons per day of ten hours, but the average is about 200 tons. The quantity necessary for the voyage is from 2500 to 4000 tons; but if coal is taken for the round trip to the Orient and back about 7000 tons would be required. This is more than can well be handled in the fifteen days that the ship is in port.

The ship lies at the wharf and receives its cargo on that side. The coal barge lies on the off-shore side, but as the ship has a longitudinal bulkhead it is impossible to trim the coal from one side to the other. It is, therefore, necessary to load coal into railway wagons and run these to the wharf, and then shovel the coal into the ports so as to counterbalance the loading on the offshore side. A continuous conveyor installed on the main deck has been tried, but as yet without success. The rise and fall of tide at this port is from 12ft. to 14ft., and the ships lie at open piers or wharves.



THE DE MAYO COALING MACHINE

GLASGOW'S NEW TECHNICAL COLLEGE.—The fine new buildings of the Glasgow and West of Scotland Technical College, which, when thoroughly completed, will be the largest of the kind in Britain, and cost about £300,000, are to be officially opened on Thursday, 21st, the Right Hon. the Marquis of Linlithgow, Secretary for Scotland, having agreed to perform the ceremony. Only the first section of the buildings, as they will ultimately be, has meantime been completed, and some of the classes have been held there since September. Following upon a luncheon to be given by the chairman of the college, Mr. W. R Copeland, the opening ceremony will take place in the examination hall of the college at 3 p.m., in the presence of the subscribers to the building fund, the staff of the college, and representatives of public bodies and institutions in Glasgow and district. A conversazione will be held in the evening, when the rooms of the institution will be open to an invited company of between 3000 and 4000 people, and a masque will be performed during the evening by the students of the School of Art.

AMERICAN ENGINEERING NEWS.

Salt River irrigation dam. — A dam, 260ft. high, and 230ft. above ground, is the principal feature of one of the great irrigation projects now being carried out in the Western States by the United States Government. It is also notable from the fact that, owing to the situation, the cost of cement would be so great if brought in by rail that the Government have established a special plant on the site to make cement from suitable local material. The dam will be about 650ft. long, curved to a radius of 400ft, and with a thickness of 16ft. at the top and 155ft. at the base. The face is vertical for 60ft. from the top, and then batters to 10ft. from the vertical line at the base. The rear has a curve of 140ft. radius to a depth of 80ft. from the top, and then a stepped slope of 2ft. to 3in. to 25ft. from the bottom; thence vertical. Under the base, and 15ft. from the face, is a toe wall 10ft. wide and 6ft. deep. At each end of the dam is a wasteway channel 200ft. long, having its crest 20ft. below the top of the dam. These channels are spanned by arched concrete bridges, with three 60ft. arches. Water for a hydro-electric plant will be drawn off by a canal, but in the rock forming the abutment of the dam a flushing and supply tunnel will be driven, being fitted with Stoney gates made to operate under a head of 230ft. The dam will be of broken-range cyclopean rubble masonry, with as little mortar and concrete as possible, and blocks weighing about 10 tons will be used as far as possible. The stone is a hard, red sandstone, quarried on the site. The concrete filling between the blocks will be composed of one part Portland cement, 2½ parts sand, and four parts of 2in. broken stone. Floods of 4000 cubic feet per second may pass over the dam. This dam will form a reservoir of over four billion gallons for the irrigation of about 250,000 acres.

Compressed air plant for railway construction.—For the construction of a nine-mile contract on a new line in heavy rock excavation for the Pennsylvanian Railroad the contractors established a central air compressing plant. This has twenty-four boilers of 100 horse-power and eight single-stage air compressors, each with a 24in. steam cylinder and a 24½in. air cylinder, both of 30in. stroke. These have a speed of 80 revolutions per minute, with a piston displacement of 1223 cubic feet per minute, giving a total capacity of 9784 cubic feet per minute delivered at 95 lb. pressure. The compressors deliver to four vertical cylindrical receivers, 5ft. diameters and 14ft. high, connected to a 12in. air main. From this extend two mains, one 3250ft. and the other 3650ft. long, laid on the surface of the ground. The branches and sub-branches aggregate 40,000ft., and the longest transmission line is 5½ miles long. For the heavy rock cutting along the cliffs fronting on the river, 5½in. vertical holes were put down to depths of 75ft. to 135ft. by means of thirty-four well-drilling machines, giving a churning motion to the drill rods by a rope and drum. Each had its drill frame, engine, and boiler, the air pipe being coupled up to the boiler. On a level with the bottom of these holes, horizontal holes were drilled by 250 rock drills, the holes being from 2in. to 4½in. diameter and up to 35ft. in depth. The air pressure is used also for about sixteen blacksmith forges along the line, six pneumatic drills, three pumps with cylinders 6in. and 4in. by 6in., ten hoisting engines with cylinders 6in. by 8in., and a steam excavator. The air is also used for clearing out the drill holes. The large central boiler plant was much more economical than would have been the 200 or more small boilers for single machines or small groups of machines, while the supply of coal and water to all these boilers scattered through a rough country would have been a difficult and expensive matter.

Fig 2—LENNE BRIDGE—CENTERINGS IN POSITION

CONCRETE BRIDGE OVER THE LENNE.

THE wooden road bridge traversing the Lenne River near Halden, Westphalia, has recently been replaced by a vaulted bridge in rammed concrete, the contract for which was granted to Messrs. Hüser and Co., of Obercassel.

The total clear width of 66·5 m. was separated into three parts, a three-hinged arch of 25 m. span being arranged in the middle of the river, with an arch of 18·5 m. span on each side. The pitch of the central arch is 2·75 m., and of the two lateral arches 1·85 m.; the crown is ·50 m. in thickness, and the abutments ·50 m. in the central arch and ·65 m. in the lateral arches respectively.

Calculations were made for a load made up of a steam roller of 20 tons weight and a crowd of 500 kilos. per square metre —say, 111·3 lb. per square foot. The three-rammed concrete hinges arranged in the central arch form a special feature. The two smaller lateral arches are fitted with lead plates in the crown and abutments. The rammed concrete hinges—see Fig. 3—have a convex curvature of 2 m., say 78·75in., radius, and a concave curvature of 3·13 m., say 122·6in. A mixture of one part Portland cement, two parts washed Rhine sand, that had been passed through a sieve of 4 mm. mesh, and two parts washed and broken coarse Rhine gravel —the mixture being made by means of a Hüser mixer—was used in connection with the hinges. Just enough water was added to allow the concrete to show a slight plasticity after the ramming had been completed. The concrete was rammed in layers of 10 cm. thickness with iron rams, and endeavours were made to strike each point of each layer twelve times. No cast iron moulds were available for forming the rolling surfaces of the square stones used for the hinges, and hard plaster moulds were prepared instead. These, though they had to be made anew for each square stone, worked out at a much smaller cost than cast iron moulds, but allowed an accurate, faultless hinge surface to be produced. Pressure tests on a series of five test cubes, made at the same time, of the same material, and hardened under exactly the same conditions as the hinges, showed an average strength of 300 kilos. per square centimetre—4265 lb. per square inch—after twenty-eight days. On the day the centers were taken down from the vaults the square stone swere about one hundred days of age. The test cubes had reached at the same time a strength of about 360 to 400 kilos. per square centimetre—5174·7 lb. to 5686 lb. per square inch—as an average. Another test was made on a test cube of 125 days age, showing a strength of about 700 kilos. per sq. cm., say, 9952 lb. per square inch. From these experiments a factor of safety of 5 or 6 to 1 could be depended upon. With a view to compensate for any small defects in curvature on the hinge surface, soft lead plates 2 mm. in thickness and 250 mm. in breadth were arranged between the hinge stones, these lead plates being placed between two brass sheets ·08 mm. in thickness, so as to reduce the friction in the hinges. The working of these concrete hinges was found, so we understand, to be quite satisfactory. Their effect was distinctly noticeable when the centers were struck, and with any considerable variations in temperature. As no accurate measurements of the movements of the hinges were possible in taking down the centers, an elementary experiment was made to ascertain the effect on the hinges. In the neighbourhood of the inner and outer bow lines the open joint ends of the hinge stones was lined with a plaster coating on the arch front. After the centers had been taken down, resulting in a small lowering of 14·52 mm. in the centre of the arch, the upper plaster coating was found to be distinctly crushed in the crown hinge, while in the lower coating a small hair-like crack was observed. At the abutment hinges, where the movement was only half that in the centre of the arch, no alteration was observed.

Fig. 1—CONCRETE BRIDGE OVER THE LENNE

The bridge is shown in course of construction in the engravings, Figs. 1, 2, and 4. The ramming work was fraught with special difficulty, and pumping had to be carried out during the whole of the excavation. No lowering or contraction of the centering was observed during the construction, which indicates that considerable care had been devoted to the timbering. The concrete work on the vaults was carried out in separate sections so as to submit the timbering to as uniform a load as possible, and to make the contraction symmetrical. The various sections were made in layers 20 cm. in thickness, with radial ramming, the concrete consisting of one part Portland cement, four parts washed Rhine sand, and six parts broken gray stone. Test cubes showed a mean strength of 172 kilos. per square centimetre after twenty-eight days.

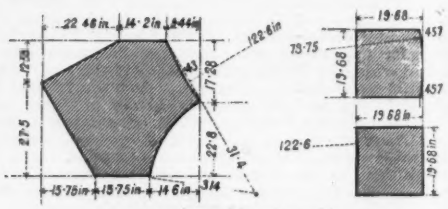


Fig. 3—DETAILS OF HINGE

Fig. 4—LENNE BRIDGE—CONCRETE WORK IN PROGRESS

THE Norwich Town Council at the last meeting decided to purchase a steam motor wagon, with interchangeable water tank, at a cost not exceeding £565. They have already one steam wagon in use.

THE DETERMINATION OF THE PRINCIPAL DIMENSIONS OF THE STEAM TURBINE WITH SPECIAL REFERENCE TO MARINE WORK.*

By Mr. E. M. SPEAKMAN, Associate Member.

(*Concluded from page 502.*)

IN Table II., the vane speeds adopted in various classes of work are given, and the reduction in peripheral speed on account of the propeller reducing the revolutions, and the necessary proportion of blade height modifying the diameter may be clearly seen. To this combined action is due the fact that only in the faster classes of vessels, or in those small types in which some propulsive efficiency can be sacrificed, is the turbine applicable. In slow cargo steamers, though the revolutions may be high enough, the power required is not sufficient to enable a reasonable blade height to be adopted, and it is this consideration, viz., proportion of leakage over blade tips, that curtails the wider adoption of this type of turbine. For the same low peripheral blade speed, other types of turbine are unsuitable on account of the impossibility of reducing the steam velocity sufficiently without abnormal weight and inefficiency.

TABLE II.—*Marine Work.*

Types of vessel.	Peripheral vane speed		Mean ratio of Vt—Vs.	Number of shafts.
	H.P.	L.P.		
High-speed mail steamers ..	70-80	110-130	·45-·5	4
Intermediate do.	80-90	110-135	·47-·5	3 or 4
Channel steamers	90-105	120-150	·37-·47	3
Battleships and large cruisers	85-100	115-135	·48-·52	4
Small cruisers..	105-120	130-160	·47-·5	3 or 4
Torpedo craft	110-130	160-210	·47-·51	3 or 4

Electrical Work.

Normal output of turbine.	Peripheral vane speed.		No. of rows.	Revs per minute.
	1st expansion	Last expansion.		
K.W.				
5000	185	330	70	750
3500	188	280	75	1200
2500	125	300	84	1360
1500	125	360	72	1500
1000	125	250	80	1800
750	125	260	77	2000
500	120	285	60	3000
250	100	210	72	3000
75	100	200	48	4000

The smallest size of marine turbine is usually larger than the average electrical turbine as far as power is concerned, and therefore does not meet with the same commercial considerations as the smaller sizes of the latter type. These are not designed for the same internal efficiency as the larger machines, chiefly on account of manufacturing cost, and they do not attain anything like the same efficiency compared with the Rankine cycle.

Speaking in reply to the discussion on his paper to the Institution of Naval Architects in 1903, Mr. Parsons said that, "for all practical purposes, while the steam is traversing each set—of blades—as shown, it behaves like an incompressible fluid, just like water would do, as the expansion is very small at each set. The frictional losses and the eddy-making losses would be practically identical within small limits with what they would be with water, and the actual forces would be in proportion to the density of the medium. . . . In the turbine blades themselves, the efficiency is between 70 and 80 per cent."

Using this hydraulic analogy enables us to calculate the number of stages required in a different manner. The "equivalent head," due to the steam pressure, may be found, together with that at each row necessary to give the required velocity, from which both the number of stages and the coefficient of expansion at each stage may be worked out.

In the early marine designs, such as the Queen Alexandra and H.M.S. Amethyst, the turbine drums were all made of the same diameter, and the higher speed necessary on the low pressures was got by running at considerably higher revolutions than on the high-pressure shaft; but, following up the increase in propeller efficiency found to be due to the use of larger screws the speed for each shaft is now more nearly equal, while the wing drums are made larger in diameter. The vagaries of the following wake, however, necessitate slightly different propeller dimensions on each shaft, or else slightly different revolutions with the same screws; and it is noticeable that in a triple-screw arrangement, the centre screw being right-handed and the wing screws revolving outwards, that the starboard propeller is influenced by the centre one, and almost invariably revolves at a lower speed. In a four-shaft design, due to the varying wake values at different speeds, and possibly, also, to some unequal distribution of power, the outer screws run slower at low speeds, and faster at high speeds than the two inner shafts, but exact data as to this, and the possibility of allowing for it in the design, are still wanting.

In all types of turbines—Parsons', Rateau, Curtis', &c.—a certain ratio must be maintained between the blade velocity and steam velocity, and, as steam acquires very high velocities by expansion, the blade velocity must be maintained either by the revolutions or by large diameters, or both. As the weight increases very rapidly with the diameter, and extraordinarily so with the reduction in rotative speed, it is preferable to increase, if possible, the revolutions, or the number of stages, rather than the diameter, and especially should this be done in cases where, as in the Rateau or Zoelly types, the weight increases more rapidly in inverse proportion to the revolutions per minute and the diameter than it does with other types. To increase the revolutions, it may be necessary to increase the number of shafts and propellers, thus reducing the power per shaft and the effective thrust through each screw. Increasing the diameter of the turbine adds largely to the constructional difficulties, especially of the cylinder.

Having obtained the number of rows and the diameter, the blading arrangement can be worked out in detail. The height of blade depends on the volume of the steam, and the speed at which it is to flow, and also on the ratio of the area of exit openings between the blades to that of the annulus between spindle and cylinder, which is about one-third in normal blades. The necessary clear area to pass the steam being equal to volume ÷ velocity, and knowing this annular factor, say 3, for a ratio of one-third—or 2 for ½, &c.—then

$$\text{Height of blade in inches} = \frac{\text{Clear area in square inches} \times 3.}{\text{Mean circumference in inches.}}$$

The ratio of blade height to mean diameter should not be less than 3 per cent., or more than 15 per cent., because in the former the leakage will be excessive, and in the latter the bending moment on the blade becomes too great, and the radial divergence of the blades too much. The width of blade, the shape of section adopted, and the circumferential pitch are standard considerations, and affect the factor 3 given above. It is not proposed to enlarge upon them in this paper. It may, however, be remarked that for $\frac{V_t}{V_s}$ greater than ·6, the usual shape of Parsons' section, as shown in Fig. 4, should be modified to a somewhat different form of blade, with a sharper entrance edge. This section is not to be recommended, as, owing to the necessity of strengthening the blade sufficiently, the metal must be placed nearer the exit edge, thus increasing the angle between the face and the back of the exit edge of the blades, and giving, in fact, an inferior shape of opening compared with that obtainable with a blade section adapted to ratios under ·6. If, for the present, it is sufficient to use the blade sections and packing pieces similar to those now adopted so generally, in Table III. can be found a list of widths for a given height, and the axial spacing of the rows. While this must be kept down to reduce the length of drum, it must be sufficient to allow for some play in overhauling; and sufficient clearance can be allowed here without affecting the economy. The openings between the blades to allow of the passage of the steam are very important, and must be carefully designed. The actual volume of the steam—not the volume per lb., as found in tables, or the volume due to adiabatic expansion, but the exact volume per lb.

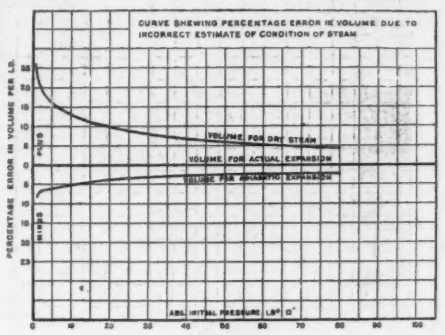

CURVE SHEWING PERCENTAGE ERROR IN VOLUME DUE TO INCORRECT ESTIMATE OF CONDITION OF STEAM
VOLUME FOR DRY STEAM
VOLUME FOR ACTUAL EXPANSION
VOLUME FOR ADIABATIC EXPANSION
PERCENTAGE ERROR IN VOLUME PER LB.
PLUS
MINUS
ABS. INITIAL PRESSURE LBS. □"

Fig. 9

TABLE III.—*Standard Blading Dimensions.*

Height (H), inches	1	2	3	4	6	8	10	12	15	18	21	24	30
Width (W), inches	⅜	⅜	⅜	⅜	½	½	⅝	¾	¾	1	1	1¼	1¼
Pitch (P), inches	1⅛	1⅛	1¼	1⅜	1½	2⅛	2¼	2⅜	2⅝	3⅛	2¾	1⅞	4
Axial clearance (C), inches .. .	1/16	1/16	⅛	1/16	⅛	1/16	⅛	⅛	1/16	1/16	⅛	¼	⅛
Gauging factor	3	3	3	3	3	2·5	2·5	2·5	2	2	2	1·5	1·5
Section number													
Spindle packing piece number .													
Cylinder ditto													

NOTE.—While the above represents general practice, it is obvious that such a table is largely arbitrary.

at any point along the turbine—must be determined, in order to arrive at the desired adjustment of velocities. It is extremely doubtful whether the present blading arrangements give the best results; greater accuracy of calculation, and consequently improved pressure distribution and efficiency, seem likely to follow the use of a more mechanical blading construction.

Fig. 9 shows the percentage error involved in using either the dry volume, or that due to adiabatic expansion, compared with the correct volume corresponding to the actual expansion in a large turbine using dry saturated steam at the first row of blades and 27in. vacuum. Attention must be paid to the effect of approximately adiabatic expansion and the consequent moisture in the steam.

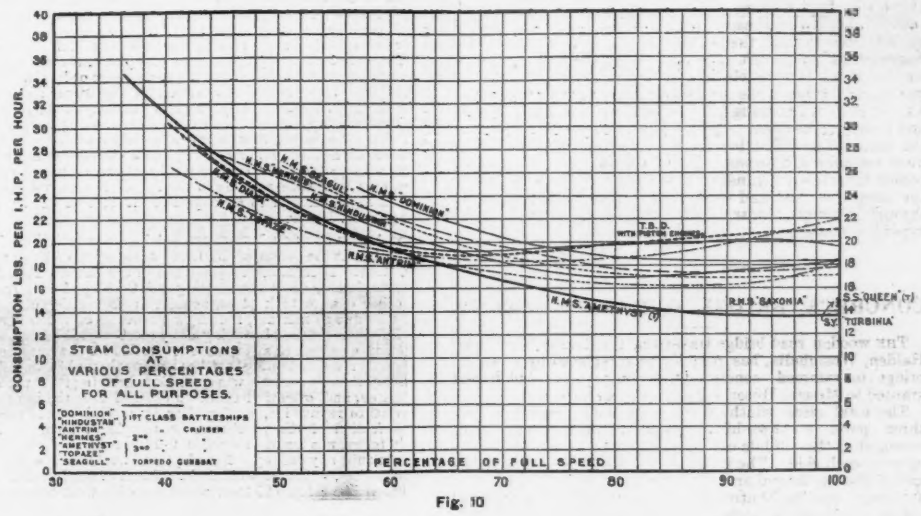


Fig. 10

For manufacturing convenience, as well as to allow for the expansion of the steam, the blade heights are stepped up, but no rule exists for this; the blades might be of one, or of sixty-four heights, provided the blade openings are correct. It is, however, convenient to step them, as in Fig. 4, say, in 8 steps of 8 each, or 4 of 16—even 9 of 7 would do—and so avoid any great variation from the annular area factor 3 as shown above. To obtain heights and areas, it is best to plot off, graphically, volumes, steam speeds, and clear areas required. The use of standard blade heights will then enable the number of stages and rows per stage to be determined; wide differences can be made in any arrangement without materially affecting the economy. The best arrangement is largely a matter of convenience and experience.

The material of which blades are usually made is a mixture of cheap brass containing about 16 per cent. of copper and 3 per cent. of tin. Alloys containing zinc are extremely unreliable for high temperatures, but blades containing about 98 per cent. of copper have been found very satisfactory for use with high superheats. More recently a material containing about 80 per cent. of copper and 20 per cent. of nickel has been adopted, and this is undoubtedly the best blading material existing. Steel blading, drawn in the same way as the usual brass section, has been used in the United States with fairly good results. The process of drawing turbine blades gives an extremely tough skin to the metal used, not only increasing the tensile strength, but greatly decreasing the chances of erosion.

It seems probable that the usual caulking piece now adopted will be discarded in favour of a machine-divided strip into which the blades may be fitted, and instead of the slotting, wiring, lacing, and soldering process at the tip, a similarly machine-divided shroud will be used, gixing a far stronger construction, and enabling finer clearances and better workmanship to be obtained; at the same time considerably reducing the cost of manufacture, and the risk of blade stripping.

The chief causes of the latter may be set down to bad workmanship in fixing the blades, defective blade material, excessive cylinder distortion—this is probably the most fruitful cause, and is a serious one, being due to bad design—whipping of turbine spindles—which is also due to bad design, or bad balancing—wear of bearings — which is very remote — and the introduction of extraneous substances, such as water or grit. In fact, blade-stripping may be said to generally occur from preventable causes. Small vibrations of very high frequency occasionally set up an action in certain rows of responsive length that fatigues the blade material, and causes the loss of blades without any fouling at all.*

Due to the action of the steam, an end thrust occurs in the direction of the propeller, which is advantageously used in partially balancing the propeller thrust, thereby reducing the size of thrust block necessary. A margin must be allowed here, and the propeller thrust is not entirely balanced by the pressure on the annulus between the dummy-ring diameter D, and the spindle Fig. 5, C, plus the end pressure on the blades. For the diameter D to give the required annulus, as well as that of the propeller, the effective thrust must be carefully calculated; and experience shows that there is a drop in steam pressure varying from 10 lb. to 15 lb. per square inch between the pipe inlet to the high-pressure receiver and the first row of blades, which should be considered in designing this balancing area. The number of rows of dummy packing used varies according to the designer's judgment very largely, and may be modified according to the pressure and the clearance allowed, say, a $\frac{7}{1000}$th to a $\frac{15}{1000}$th of an inch in electrical work, and rather more in marine work.

The dimensions of the astern turbine are arrived at in the same manner as those of the ahead, the efficiency being largely sacrificed on account of weight and space, generally, the mean diameter is made practically the same as that of the high-pressure drum.

To a large extent, the inferior manœuvring capabilities of the earlier turbine steamers were due to insufficient astern power.

The pressure on the bearings in a turbine is only due to the weight of the spindle, plus the negligible addition in marine work, of that due to any gyroscopic action; it may be taken as from 80 lb. to 90 lb. per square inch as long as the rubbing velocity does not exceed 30ft. per second. If it does, the pressure must be reduced so that the product of pressure × velocity does not exceed 2500-2700. In land work, 50 lb. × 50ft. is very common. The friction heat of the bearings added to that due to conduction through the pedestals necessitates the use of large oil coolers, and in the case of very high temperatures, of special kinds of oil. If possible, the bearing temperature should not exceed from 140 deg. to 150 deg. Fah., though the writer has known of 190 deg. Fah. being used without trouble. In marine turbines this temperature is usually much lower. Rigid bearings are used for marine spindles, not the flexible type adopted in land work.

Space does not permit of more than passing reference to cylinders; but it would be difficult to exaggerate the importance of very careful design in this connection. Cylinders with heavy flanges on the centre line distort in a very curious fashion when heated with their axes horizontal, and measurements taken off a hot cylinder on a surface plate with micrometer gauges reveal some very remarkable facts. When working, the temperature along the cylinder falls possibly from 400 deg. to 100 deg. Fah. in a distance of 6ft. or 8ft., and, unlike the reciprocating engine, this remains constant; the radial expansion is consequently more at one end than the other, while at any point along the turbine the tendency is to expand less at the flanges than at the top and bottom. For this reason ample clearance must be allowed. Exactly what this will be when spindle and cylinder are hot is hard to say, but it seems most likely that the total clearance area will differ but little from what it is when cold.

The longitudinal expansion when hot is often very marked, and in all turbines necessitates provision for the resultant movement at one end. In marine work the after end of the cylinder is secured to the vessel, the engine seating also performing the function of a thrust-block seat, while the forward end slides forward, taking with it the entire shafting. The thrust block is at the forward end of the cylinder, and also performs the duties of an adjustment block for setting the longitudinal clearances, to do which generally necessitates uncoupling the shafting abaft the turbine.

The difference in expansion between the cylinder and spindle, from the thrust block to the dummy ring, may be the cause of serious difficulties in large marine turbines, unless the closest

* The Institution of Engineers and Shipbuilders in Scotland.

* The writer had experience of this early in 1905, when a 5000-kilowatt turbine, under test in one of the large New York power stations, shed several rows of blades. This difficulty has also occurred in Europe, and can be circumvented by an alteration in the position of the lacing strip.

attention is paid to this feature in the design; and "warming up" with these large cylinders needs possibly even more care than is essential with large piston engines.

On shipboard the turbine cylinders are practically under one's feet, and the radiation from them is very unpleasant, especially if there is any leakage from the glands. To all who are responsible for the lagging of cylinders and the system of ventilation in turbine engine-rooms I would call attention to the possibility of their having to stand a watch of four or six hours on the top of the high-pressure cylinder, such as is the case in the Eden or Amethyst, the heat in the latter vessel being almost unbearable. With reciprocating engines one stands on a comparatively cool lower platform with the cylinders overhead, and with some chance of the hot gases rising clear; but in naval turbine work under a low deck this point has not met with adequate attention.

In the course of operation, more especially in marine work where no superheaters are used, there is a distinct tendency for the turbine to be supplied with wet steam, the effect of which on the

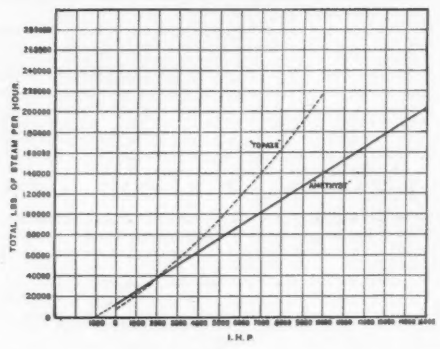


Fig 11

economy is very marked. Experiments that have been made show that the percentage increase in consumption is about twice that of the moisture in the steam. For instance, with 2 per cent. of moisture in the steam at the first row, the consumption is increased about 4 per cent.

A considerable amount of data on the performance of turbines compared with reciprocating engines for marine work is now available. The Admiralty has had tested both cruisers and torpedo-boat destroyers, exactly similar but for their engines and propellers, and trials of the Midland Railway Company's steamers and other cross-Channel boats have corroborated the results regarding economy obtained from the naval vessels. In Fig. 10 is given the steam consumption per unit of power of H.M.S. Amethyst* compared with that of several recent warships, and it is noticeable that only below from 55 to 60 per cent. of their full speed does the consumption of the turbine exceed that of the piston engines. Very seldom do vessels steam below these speeds. Cruisers carrying relief crews to the China or Australian stations usually proceed at about 60 per cent. of full speed, and in the Atlantic manœuvres of 1903 nearly 80 per cent. of full speed was maintained by the large fleets, whilst the Japanese battleships built in England made their first voyage to Japan at about 54 per cent. of their full speed, at which ratio the consumption per indicated horse-power of both the Hindustan and Dominion, representing very recent battleship construction by eminent builders, is materially in excess of that of the first installation of warship turbines—not including the destroyers. The total consumption of H.M.S.'s Amethyst and Topaz plotted on a base of power is given in Fig. 11, while Fig. 12 shows that for the Midland Railway boats.* The pro-

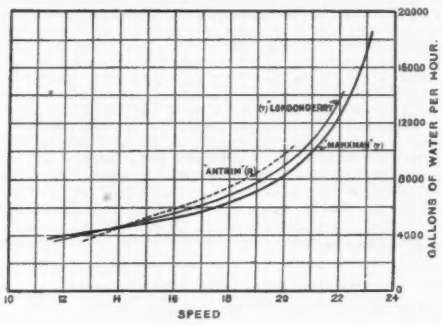


Fig. 12

gressive trials of H.M.S. Amethyst are shown in Fig 13, and, in view of the results obtained from these various vessels, the wholesale adoption of turbine machinery in the Royal Navy is not surprising.

It is probable that the adoption of cruising turbines will be discontinued before long, and this view seems to be corroborated by the consumption trials of the Midland Railway steamers. Down to 60 per cent. of her full speed, the Manxman required less water than the highly efficient Antrim, and with a different blading arrangement in the main turbines, such a result should be equalled, if not improved on, in war vessels. The additional complication involved with two cruising turbines and their accompanying leakage and receiver losses, together with a considerable increase in weight and space occupied, largely modifies any advantages obtainable in the way of reduced consumption at lower powers. An improved—and easily obtainable—design of main turbine blading should give a better result at the highest powers, practically the same at intermediate powers—as in the case of H.M.S. Amethyst, from 14 to 20 knots—and only slightly inferior at speeds below 14 knots, while it will undoubtedly admit of greater ease of handling and be much simpler. In a triple shaft arrangement the unequal distribution of power on the wing shafts, due to the use of cruising turbines, is a distinct disadvantage; the fluctuation in rotative speed, due to shutting off the high-pressure cruising turbine, may be seen from the trials of H.M.S. Amethyst.

In conclusion, the writer would remark that it is impossible in the scope of a paper such as this to touch more than lightly on a subject which is of such vast importance. Many of the points dealt with above, such as cavitation, blading, cylinder design, &c., would require a volume to describe. While turbines perhaps are still in their infancy, they are already largely supplanting the reciprocating engine in many types of vessel. The next few years will undoubtedly show as great an improvement as has taken place since the advent of the King Edward barely five years ago, the more especially as the subject will, henceforward, be engaging the attention of all engineers instead of a few specialists, and that this improvement will more than justify the policy of the Admiralty and of the Cunard Company is already certain.

It should be a matter of some satisfaction to the members of this Institution that the present status of the marine turbine, if

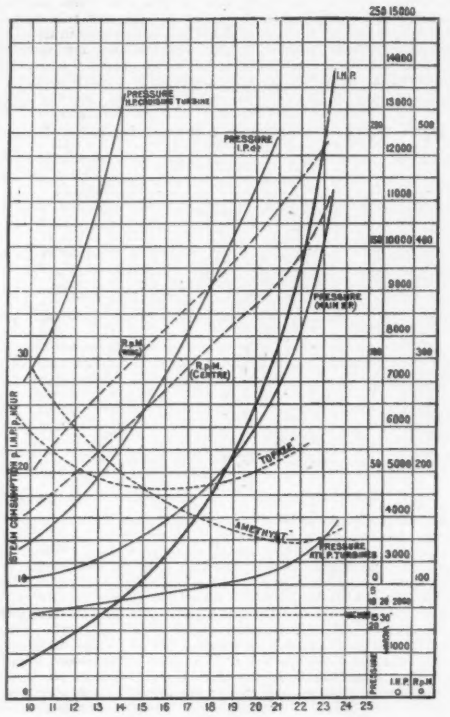


Fig. 13

not absolutely due to the Clyde alone, is at any rate entirely a product of Great Britain.

BY-LAWS FOR LOCOMOTIVES.—The Public Control Committee of the London County Council, at the last meeting, submitted a report recommending the adoption of new by-laws for locomotives, and further, that the President of the Local Government Board be asked to receive a deputation from the Council on the subject of the promotion of fresh legislation to amend the Locomotive Acts on the following lines, and that the Public Control Committee be authorised to take the necessary steps in the matter:—(1) That all locomotives and trailers shall be fitted with suitable springs; (2) that licensing authorities shall be empowered to refuse to license any locomotive which is not so constructed as to avoid unnecessary noise or vibration subject to an appeal to a magistrate in case of dispute; (3) that the weight of engines shall not exceed eight tons on any axle, such weight to apply to towns only; (4) that the weight of a trailer and load shall not exceed 12 tons; (5) that licensing authorities shall be empowered to weigh vehicles; (6) that the present limit of width of locomotives and trailers—viz., 9ft.—shall be reduced; (7) that no locomotive shall be allowed to draw more than two trailers in towns.

GLASGOW UNIVERSITY ENGINEERING SOCIETY.—At a meeting of the above Society, held on 23rd November, 1905, in the James Watt Engineering Laboratories, the University, Mr. H. A. Mavor, of Messrs. Mavor and Coulson, delivered a lecture on "The Art of Approximation" to a large and appreciative audience, Professor Barr in the chair. The lecturer showed that, having obtained a knowledge of the principles of solution of engineering problems, another course of education is required in the application of this knowledge to the data available as the bases of calculation. These bases are, as a rule, only approximations, and skill has to be employed in the selection of the elements of calculation; otherwise the results are valueless. There are two main objects of search in engineering calculations:—(1) Relation between dimensions and useful effect; and (2) relation between useful effect and cost. Neither of these objects can be finally accurately attained, and certain elements, which affect the result more or less, have to be discarded. This process of selection of the bases of calculation is evidently at least as important as accuracy in the calculation. Even the fundamental bases of calculation—distance, mass, time, and price—are not themselves accurately ascertainable, and a selection of means of ascertaining these dimensions has to be carefully made, so that the resulting calculations of useful effect and cost may bear some relation to the facts. Experience in estimating these is essential to an engineer. A vote of thanks was awarded to Mr. Mavor.

LEEDS ASSOCIATION OF ENGINEERS.—A lecture was delivered on Saturday last at the rooms of the Leeds Association of Engineers, by Mr. Robert Buchanan, the president of the British Foundrymen's Association, on "The Melting and Cooling of Cast Iron." If no other change took place, he said, in the melting of metal, except that due to mixture, foundrywork would be much simplified. But the need was becoming daily more urgent of knowing how to mix cast iron so as to make it suitable for the purpose required, and of understanding how the result was brought about. The purchase of iron by analysis was spreading, bringing its reward to the initiated, and, even if it could be claimed that the irons sold were equal to reputation, confirmation by analysis would add to the satisfaction of the purchaser. A sample of hematite iron recently tested was found to contain 0·22 per cent. of sulphur—enough to ruin any casting. Foundrymen should look well after their hematites, which were often the refusals of steel works. He had himself just refused 25 tons, which probably went to someone who did not analyse. His own method of mixing on the basis of analysis included the deduction of 0·10 per cent. of manganese and 0·25 per cent. of silicon lost in one melting, and the addition of ·038 per cent. of sulphur gained. The gain of sulphur in each melting was prohibitive of large quantities of scrap, as with over ·1 per cent. the castings would be difficult to machine. Mr. Buchanan went on to show the effects produced by chemical combination, resulting from the admixture of various irons by magnifications of the surface markings thrown upon the screen. The processes of combustion in various types of cupola, notably in the Mackenzie, Whiting, Greener, Herbertz, and Thwaite cupolas, were explained, also the difference in the result of slow and rapid cooling, and the effect of annealing. Melting on the basis of analysis, said Mr. Buchanan, was the only certain method, and when once results were arrived at, the work of any one man could be taken up where he might have to leave it by his successor.

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* Since the above-mentioned results were obtained, the steam piping has been altered so as to permit the auxiliary exhaust steam to pass through the main low-pressure turbines when desired. This arrangement considerably decreases the consumption at low speeds, bringing the Amethyst's consumption below that of her sister ships down to 10 knots, or about 45 per cent. of full speed.

* Fig. 12 is compiled from the results given in Mr. Gray's paper to the Institution of Naval Architects, July, 1905.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

A LITTLE uneasiness is beginning to be felt in trade circles in consequence of the uncertainty of the political situation, but there is as yet no serious disturbance to trade, such as has been the case at some previous periods of political difficulty, for manufacturers are mostly well off for work, and hold contracts sufficient to keep them well engaged in some cases throughout the spring. Municipal contracts are affording a considerable amount of work in connection with electric lighting, water supply, tramway and general road-making and building material. The South Indian Railway Company, Limited, is in the market for locomotive stores comprising copper and steel plates, tires, axles, springs, brass and steel tubes, iron wire fencing, and roofing and general stores. Midland engineers and contractors note with expectant interest that the Battersea Borough Council are about to lay out £10,890 for electric light installation purposes, Southwark Borough Council nearly £8000 for a similar purpose, and Bethnal Green Borough Council £10,000 for paving works. There is a good demand for suction gas plant, gas engines, and pumping machinery. Local tenders have been sent in for the supply of half-a-dozen steam rail motor cars for the Great Northern Railway Company of Ireland. The extensions at Bristol Docks are causing Midlands tenders to be prepared for hydraulic winding engines, chains, capstans, and fender-chains required in connection with that important undertaking. A considerable amount of material is being asked for by various Indian railways just now, including railway locks, steel and iron work for bridges, dog spikes, wire for fencing, brass hinges, bolts, and other requisites, much of which will probably be obtained from this district.

The iron and steel trades remain firm and confident this week, marked bars being still quoted £8 10s.; unmarked, £6 15s. to £7; and galvanised corrugated sheets, £12 to £12 5s. Steel is active, angles being £6 15s. to £7; girder plates, £7 10s. to £7 15s.; and Bessemer billets, £5 to £5 5s. Pig iron is in good demand at prices ranging from 55s. for Staffordshire cinder forge up to 105s. for cold blast.

The employment of producer gas plants is making great headway in Birmingham, and the City Council have found it necessary to take steps to meet this competition with the town gas. The Gas Committee have, therefore, prepared a report for presentation at a meeting of the Council on the 5th of December, containing a recommendation relating to a reduction in the price of gas for motive power purposes. On the 25th of July last the Committee recommended the Council, in view of the charges made by other undertakings then cited, and in view also of the manufacture of a gas that could, under favourable conditions, displace town gas, to sanction all gas used in engines, irrespective of quantity, being supplied at the lowest rate then current, viz., 1s. 10d. per 1000 cubic feet, and this was agreed to. The quantity of gas supplied by the department for use in engines is approximately 960 million cubic feet per annum, or about 15 per cent. of the total quantity sold during the year ended March 31st, 1905. Apart from the loss of income that the department would sustain should producer gas be substituted for a large proportion of this output, it has to be borne in mind that the principal mains in the city are now employed carrying gas for sixteen hours during each working day, whereas their use would be more restricted and the expenses thereon proportionally greater if gas were mostly used for illuminating purposes only, and similarly the effect on all the other fixed or dead charges would be adverse to the profit-earning capacity of the undertaking if the business in power gas were unduly limited.

The effect of the recommendation contained in the last report presented by the Committee to the Council was to secure for users of small quantities of gas for power purposes reductions in price from 2s. 6d., 2s. 3d., and 2s. to 1s. 10d. per 1000 cubic feet, but no reduction was then made in favour of the larger consumers of gas for motive power. The Committee are now, however, of opinion that the price of gas for motive power should be further reduced, and, therefore, they recommend that from and after the Christmas quarter index reading of the meters the following charges shall be made for gas used exclusively for motive power purposes:—On consumptions, in one premises, of under 100,000 cubic feet per quarter, 1s. 10d. per 1000 cubic feet, and over 100,000 cubic feet per quarter, 1s. 7d. per 1000 cubic feet, less the usual discount of 5 per cent. for prompt payment. The recommendation of the Committee will probably be approved.

Hydraulic engineers continue well engaged, mostly for British undertakings. As regards the supply of water to Birmingham, the works in the Elan Valley are now in full operation. The culverts in the Caban Coch dam are expected to be stopped almost immediately, and the effect of this will be that the Caban Coch compensation reservoir will begin to fill. Beyond this, the following works await completion:—The house over the Foel valve tower, the completion of the roadway over the Careg-ddu viaduct, compensation gauges and the turbine-houses and machinery in connection therewith; the foot bridge across the main channel below the Caban dam; the completion of roads, fencing, and trimming of banks, and general tidying up. Good progress has been made during the summer. The staff, both of workmen and officials in the Elan Valley, has been largely reduced, and the Committee are steadily effecting sales by private treaty of such plant as can be dispensed with. In continuation of their policy the Committee have arranged to plant a further area of 74½ acres on the watershed in the Elan Valley. The total area now under plantation is about 310 acres, and the areas already planted are doing well.

Pumps are in order in the district for irrigation purposes for India and Egypt, and for mining purposes for South Africa and Australia.

Both for lighting and power supply, consumers of electricity are about to get the advantage—in the shape of reduced charges—of the extensions to the generating plant which the City Council have of late effected. The Electric Supply Committee, in their report to the City Council, state that they have for some time had under consideration the desirability of making a further reduction in the charges for electric current. Hitherto, however, they have not been in a position to recommend safely a reduction or to supply the larger output which they have no doubt a reduction will bring. The approaching completion of Summer-lane station gives them the desired opportunity, and after careful consideration they recommend the adoption of a reduced scale of charges. When the new station is at work they will be in a position to deal with a greatly increased business, and, moreover, the cost of generating current will be considerably lower than at the existing stations. They have no doubt, therefore, that, though the reduced charges will entail at first such a decrease of revenue as will necessitate a recourse to the reserve fund, the change will, in a comparatively short time, lead to a large and profitable increase of business.

On last year's figures, which showed a net profit of £10,789, these reduced charges would have decreased the receipts by about £9750. Having regard to the large payments for interest and sinking fund that will have to be met on increased capital expenditure now being incurred by the department, which expenditure cannot be expected to be remunerative for the next two or three years, there is no doubt that the revenue during this period will not be sufficient to fully meet the increased charges. It will be necessary, therefore, to draw upon the reserve fund which has been accumulated to meet such an eventuality. This fund now stands at £49,393, and will be more than sufficient to meet any deficiency that is likely to arise on this account. The reduced charges, if approved, will take effect in the quarter commencing January 1st, 1906. The proposed new charges for power supply entail the following reductions:—For the first 300 units per quarter the charge is reduced from 3d. to 2d.; for any further

quantity in the same quarter up to 3000 units, from 2d. to 1½d.; where 3000 units or over per quarter are used the charge after the first 300 units is lowered from 1½d. to 1¼d.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The continued receipt of strong American advices has affected this market to some extent, but, although fair operations in pig iron have been put through, there is a perceptible lull in buying on the part of consumers. Merchants, however, are inclined to purchase, principally for covering operations. There has been rather a downward tendency in certain Scotch makes, such as Eglinton and Dalmellington, in second-hand, which continues up to the time of writing; but so far as Gartsherrie and Glengarnock are concerned, makers insist on full rates. Probably the large quantity going into stock, and which appears to be continually increasing, causes some element of uncertainty, and there has been more doing in Cleveland foundry iron for this district at a slight concession in rates on those previously ruling. There is, in the meantime, only odd lots of Lincolnshire and Derbyshire No. 3 offering, and for the last-named there was an advance of about 6d. per ton named, while Staffordshire remained unchanged but very firm. Of forge iron there is still very slight information to be got, and so long as the present high prices for foundry rule, we shall not hear much of it. Meantime, deliveries on old contracts continue, but there is difficulty in many cases in obtaining full supplies. In the engineering branch employment continues to improve, and there is every prospect of a continuance of this brisk state of things well on into the New Year. Indeed, in the textile machinery department a great deal of overtime is being worked, and men for night shifts are difficult to obtain. In finished iron the position is still strong, but there have been no changes in price to record since our last. Steel of all sorts is in brisk request. The almost startling advances in raw copper have had a corresponding effect on the manufactured article, as also on brass products. Sheets are £2 to £3 per ton dearer, and tubes, generally, ½d. per lb. more money. Sheet lead is also 10s. per ton higher in most cases. The attendance on the Iron 'Change on Tuesday was larger than usual.

Quotations:—Pig iron: Lincolnshire No. 3 foundry, 58s. to 59s.; Derbyshire, 61s. to 61s. 6d.; Staffordshire, 60s.; Middlesbrough, open brands, 62s. 4d. to 62s. 9d.; West Coast hematite, 78s. 6d. to 79s. net; East Coast, 78s. 6d. net. Scotch: Gartsherrie, 68s.; Glengarnock, 65s. to 66s.; Eglinton, 64s. 3d. to 64s. 6d.; Dalmellington, 63s. 6d. to 64s., delivered Manchester. For delivery Heysham: Gartsherrie, 65s. 9d.; Glengarnock, 62s. 9d. to 63s. 9d.; Eglinton, 62s. to 62s. 3d.; Dalmellington, 61s. 3d. to 61s. 9d. Delivery Preston: Gartsherrie, 67s.; Glengarnock, 64s.; Eglinton, 63s. 3d. to 63s. 6d.; Dalmellington, 62s. 6d. to 63s.

Finished iron: Bars, £7 to £7 5s.; hoops, £7 10s.; sheets, £8 2s. 6d. to £8 5s.

Steel: Bars, £7 5s. to £7 10s.; hoops, £7 15s; boiler plates, £8 2s. 6d. to £8 5s.; plates for tank, girder, and bridge work, £7 15s. to £7 17s. 6d.; English billets, £5 5s. to £5 12s. 6d.; foreign, £5; sheets, £8 15s. to £8 17s. 6d.

Copper: Sheets, £90 to £92; seamless copper tubes, 11d.; brazed, 10¾d.; brass tubes, 8¾d.; condenser, 9¾d.; brass wire, 8d.; rolled brass, 8d.; brass sheets, 8¾d. per pound.

Sheet lead, £18 to £18 10s. per ton.

The coal trade is quietly steady. In manufacturing coal the demand remains unabated and prices have an advancing tendency. More money is being asked on shipping account. Quotations are:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, 8s. 3d. to 8s. 9d.; best engine fuel, 7s. 9d. to 8s. 6d.; best slack, 7s. to 7s. 6d.; medium, 6s. to 6s. 9d.; common, 5s. to 5s. 9d. at the pit. Screened coal, 9s. 9d. to 10s.; unscreened, 9s. 3d. to 9s. 6d. delivered Manchester Ship Canal.

Barrow.—The hematite iron trade has been fairly steady during the week. Makers have done a good business alike in prompt and forward deliveries and are well sold forward. They are putting additional furnaces in blast, and the American furnace at Askam, near Barrow, will be producing iron again at the close of this week. It is equal to an output of 1600 tons per week, or about double the production of the ordinary furnace. High temperatures and heavier blasts are used to achieve these results. Stocks show an increase in warrant stores during the week of 2475 tons, making a total of 43,888 tons. Makers are also holding heavier stocks to order for delivery next year. Prices are steady at 70s. 6d. for mixed Bessemer numbers net f.o.b., and warrant iron sellers are at 70s. 1½d. net cash, buyers 69s. 6d. The wants of consumers are large, but there is only a small tonnage of iron passing into Bessemer steel, and this makes heavy deliveries of pig iron from the furnaces to makers all over the country. Local railway traffic receipts have therefore gone up considerably. Forge and foundry iron is quiet, but a good business is being done in spiegeleisen, ferro-manganese, and charcoal iron, and this is likely to be maintained; indeed, the demand for ferro-manganese is sufficiently strong to justify smelters in putting another furnace in blast.

There is an active demand for iron ore, and there is much business doing at local mines. The output has been increased, and will be further augmented shortly, and the heavy stocks of iron which had accumulated at native mines have now been practically cleared at the higher rate of values now ruling. Good ordinary sorts are at 15s. net at mines, and best sorts are at 19s., while Spanish ores are quoted at 19s. 6d., delivered.

There is marked quietness in the steel rail trade, as with the advance in the price of iron a corresponding advance was necessary in finished rails, and most buyers are keeping their orders back until cheaper quotations prevail. It is reported that a West Cumberland firm has secured an order for 15,000 tons of steel rails for Buenos Aires at £5 12s. 6d. per ton, or 5s. per ton below the price at which rails are quoted in the open market. £7 is about the price per ton for heavy ship plates, and orders are largely held. Merchant steel is quiet.

The order for a new floating dock of about 700 tons has been placed by the Admiralty with Vickers, Sons and Maxim.

Shipping is quiet. Exports of iron last week from West Coast ports included 3225 tons of iron and 7483 tons of steel—total, 10,708 tons, making a decrease of 835 tons on the corresponding week of last year. The aggregate shipments this year have reached 741,341 tons, being 76,424 tons more than in the corresponding week of last year.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE question of locomotive fuel contracts is engaging much attention in Yorkshire colliery districts this week. The rate for next year's supplies is expected to be settled in a few days. South Yorkshire coalowners are understood to have sent in tenders to three of the large railway companies in their district at the rate of 8s. 6d. per ton at the pit for the Barnsley bed for the first six months of the year, or 8s. 9d. per ton for the whole year; 6d. per ton less is quoted for the Parkgate seam. The new quotations, which show a rise of 3d. to 6d. per ton on prices now ruling, are what were generally anticipated. Another company, which requires supplies at this period, takes a considerable portion of its tonnage from South Yorkshire, and is expected to renew its contracts in the same market.

Rather more business is reported in the house-coal trade, caused, no doubt, by the winterly weather which is now being experienced. The metropolitan demand has been considerably better of late, and larger consignments have also been sent to the Eastern Counties, while local sales have been fully up to the average at this season of the year. Prices do not fluctuate much. Best hand-picked Silkstone is quoted at 12s. 6d. to 12s. 9d. per ton; secondary qualities making from 10s. to 10s. 6d. per ton; Barnsley, first quality "softs," 10s. 6d. to 11s. per ton; secondary samples, from 8s. 6d. per ton at the pits in owners' wagons. Household nuts are in excellent request at satisfactory rates.

As is usual at this period, a very brisk business is being done in gas coal, the Eastern Counties making heavy demands, while the gas companies and gas corporation departments in other districts are taking full deliveries under contract. The rates rule a little lower than were obtained last year, but gas coal bought in the open market fetches more money, and it is expected that new contracts will be on somewhat better rates for coalowners.

For engine fuel, slack, and smudge of ordinary sorts, the supplies are quite sufficient for the market, and prices are consequently somewhat weaker. Lancashire continues a good market, but much of what is now required there is procured locally, and with the thick seam pits working full time, or close upon it, the tonnage on the market is exceptionally heavy. There is a rather firmer tone in the coke market, contracts for blast furnace qualities for forward delivery being reported at 13s. 6d. per ton. Where the fine slack cannot be profitably used through lack of coke ovens, the abnormal output is found difficult to deal with in some quarters.

The iron market is steady, quotations remaining pretty much as previously reported. West Coast hematites are at 81s. 6d. per ton, and East Coast at 78s. per ton, both less 2½ per cent. There is not so much buying of hematites as when the forward movement in values began, the steel manufacturers having made arrangements to cover immediate requirements. Lincolnshire foundry is quoted at 56s. per ton, and Lincolnshire forge at 53s. 6d. per ton; Derbyshire foundry, 55s. per ton, and Derbyshire forge at 50s. 6d. per ton. For all classes of Swedish iron and steel there is an active demand, and prices consequently remain very firm, with every prospect of their being easily maintained.

Steel manufacturers report satisfactory business in nearly all departments. In military material there is still an absence of orders for armour plates, and no fresh work of any magnitude in that manufacture is looked for immediately. In other respects there is nothing to complain of, several of the firms being well employed on ordnance and projectiles. An excellent business is doing in forgings, and the outlook in this and kindred departments is decidedly encouraging. Specialities for electric installations and similar work are being called for to a considerable extent on home account. Although we do not hear of any large orders recently placed in tramway material, some excellent work is being done in this and allied departments.

The engineering establishments are considerably better off for work than they were, much of their activity being on account of new machinery and plant required in the extensions of local companies, chiefly in the heavy industries. Orders on account of important renewals and repairs are also finding satisfactory employment. In railway material the home companies, though they do not order in any great weights, are making more frequent demands upon local manufacturers. India and South America are at present the principal distant markets, and some very good lines have recently been placed in Sheffield and district and other parts. The wagon builders have done better during the last few weeks, and in several directions are fully employed. In the file trades activity is reported for nearly all markets, both at home and abroad. Another favourable sign is the increasing weight of material being sent by steel manufacturers into the rolling mills.

More encouraging accounts are given of the South African markets. The heavy stocks which retarded business for so long a period appear in many instances to have been cleared off. Orders in connection with the mining industry in the Transvaal have been fairly satisfactory of late, although the weight of work is still far short of what was expected would have been forthcoming by this time. But the tendency is to increased business in nearly all mechanical appliances required for the mines, and there is a corresponding improvement in the allied trades. Generally, a more confident feeling is expressed by those who devote special attention to the South African markets. Even in the lighter staple industries the business has improved upon what was done during the earlier months of the year.

NORTH OF ENGLAND.

(From our own Correspondent.)

TAKEN as a whole, a very encouraging report can be given of the condition of the iron and steel industries of this district, but that cannot very well be the case with respect to Cleveland pig iron, the prices of which are very unsettled, and are regulated not so much by legitimate business, but by the operations of speculators in warrants. The stock of Cleveland iron in the public warrant stores has increased so rapidly that now the speculators have over 666,000 tons with which to work, and that stock is being augmented every day, an average of 1200 tons per working day having been reported during November, which represents the output of about ten furnaces. There can be no question that far too much Cleveland pig iron is at present being produced, and that keeps the prices from advancing to anything like the same extent as those of hematite pig iron. Makers expect the good trade that is anticipated next year will take all the surplus iron that is now being turned out, and thus there are no signs of their reducing the output. There is a great contrast between the situation in the Cleveland and that in the hematite iron trades. While there is over-production in Cleveland iron, there is too little hematite iron made. There is likewise a stock of 666,000 tons of Cleveland iron in the public stores, but only 3396 tons of East Coast hematite iron, and while the former is added to daily the latter is stationary. The market is so much healthier for hematite iron that prices have moved steadily upwards, while the quotations for Cleveland have at intervals had to be reduced, and the rise in hematite has been more than double that in Cleveland iron. Hematite makers are practically independent of the warrant market, while Cleveland makers have practically to be governed by what the speculators are doing.

The outlook can hardly be characterised as good in the Cleveland iron trades, especially as the quietest time of the year is being entered upon, and, notwithstanding that the make is so much in excess of the requirements, it is being increased. No. 3 Cleveland G.M.B. pig iron has been sold at 52s. 9d. per ton this week both by producers and second hands, while No. 1 is at 54s. 3d.; No. 4 foundry at 51s. 9d.; No. 4 forge at 51s.; mottled at 50s. 3d.; and white at 50s., for prompt f.o.b. delivery. East Coast hematite iron is at 70s. for prompt delivery of mixed numbers, and 65s. for No. 4. Rubio ore is at 18s. 9d. per ton for prompt delivery at wharf on Tees.

The total stock of Cleveland pig iron held in Connal's on Wednesday was 666,353 tons, of which 607,756 tons was No. 3, 57,597 tons other iron deliverable as standard, and 1000 tons not deliverable as standard. Exports have shown some little improvement; up to Wednesday night from the Cleveland district they reached 76,129 tons, against 71,893 tons in October, 65,163 tons in November last year, and 91,678 tons in November, 1903, all to 28th.

According to the return submitted this week to the Board of Conciliation and Arbitration for the Manufactured Iron and Steel Trade of the North of England, the producers of finished iron in this district do not as yet appear to have profited materially by the advances that have been made in quotations, doubtless because they had a good many low-priced contracts to work off. The average net price realised for the iron delivered in the two months ended October 31st was only 1s. 0·78d. per ton more than in the previous two months, and the £6 0s. 0·34d. average was only 3s. 7½d. per ton more than at the commencement of the year. Quotations have risen a good deal more than that; in fact, since September they have gone up 15s. to 20s. per ton. The realised price reported, however, was higher than anything that has been announced since the first two months of 1904, and it is expected that the next return will give a very substantial advance. Manufacturers have produced more iron than at any time since the spring of 1904, and they delivered 20 per cent. more than in the two months ending August 31st. The advance in realised prices has not been enough to give the ironworkers any advance of wages, and £6 2s. 6d. per ton will have to be reached before anything will be due to them; then they will get 2½ per cent. The rate for puddling is now at 8s. per ton, against 13s. 3d. in the best days of the finished iron trade. About 77 per cent. of the manufactured iron produced in this district is now in the form of bars.

Business in the manufactured iron and steel industries is very active, and producers have better filled order books than they have had since 1900, and they are practically assured of full work next year. The improvement at the foundries has been delayed, but is now being experienced, and consumers have begun to buy rather freely, as they have found prices put up against them, more especially those of pipes and chairs. Steel ship plates are at £7; iron ship plates, £7 5s.; steel boiler plates, £8; steel ship angles, £8 12s. 6d.; iron ship angles, £7 5s.; parallel packing iron, £6; iron ship rivets, £7 17s. 6d.; steel joists, £6 7s. 6d.; steel hoops, £7 5s.; steel strip, £6 15s.; steel bars, £6 15s.; iron bars, £7 per ton, all less 2½ per cent. Cast iron railway chairs are up to £3 15s., and steel sleepers to £7 net. Heavy steel rails are at £5 17s. 6d. net at works.

Messrs. Thomas Summerson and Sons, Limited, of the Albert-hill Foundry, Darlington, have determined to extend their works, and for that purpose have acquired about three acres of land, a great part of which is already under cover.

A private company has been formed, and, indeed, has given the requisite legal notice for constructing a light railway from Middlesbrough to West Hartlepool direct. In connection with this it intends to erect a transporter bridge across the Tees, then proceed to Haverton Hill by the highway, next to Cowper Bewley through the fields, then to Greatham along the highway, and from thence to the Hartlepools by the Stockton and Hartlepool highway. The gauge is to be 3ft. 6in., and the line is to be worked by electricity. The scheme is likely to be strenuously opposed by the Middlesbrough Corporation, whose ferry service will be prejudicially affected; by the Tees Conservancy Commissioners, who have charge of the river; by the Stockton authorities; and by the North-Eastern Railway Company.

The shipbuilding industry is as brisk as ever, and now the builders are securing very fair prices. Last year they had to accept orders for cargo steamers at under £5 per ton, whereas the prices paid for steamers recently ordered work out at something like £6 10s. per ton.

The activity in the Spanish ore trade has led to owners in Bilbao acquiring steamers more freely so as to have the business more in their hands. Generally second-hand steamers are purchased.

The wages question at the shipyards on the North-East Coast is engaging special attention. Last week the employers offered temporarily several sections of the shipyard engineers half of what they asked, and the men have yet to vote whether they will accept the compromise. The boilermakers, who in July last made an application for 5 per cent. advance on piece and 1s. 6d. per week on time rates, have renewed their application. They were in July told that their request was premature, for the bulk of the orders had been taken at low prices, and would leave very little profit. The employers will meet the men on Monday next to discuss the renewed application. The North of England Brass Turners', Fitters', and Finishers' Society has put in a claim for 2s. per week advance on time and 5 per cent. on piece prices, while the National Association of Gas Workers and General Labourers apply for 1s. per week advance on time and 5 per cent. on piece rates for platers' helpers, strikers, labourers, countersinkers, and scarfers in the North-East of England. The machine workers' wages have also to be settled.

The coal trade is dull in the steam coal branch, but active in the gas, bunker, and smithy coal departments. The demand for steam coal has not been so poor since the early part of the year, and a quiet time is looked for over the next three months. But steam coals can be got at as low a figure as 8s. 9d. per ton f.o.b., but 9s. has to be paid for gas coals. The North-Eastern Railway contracts for the delivery of locomotive coal during 1906 have been placed, and, as a rule, they will pay the Northumberland and Durham coalowners about 6d. per ton more than they have been giving during 1905. Coke is in rather better request, and 17s. per ton is asked for medium qualities, delivered next half year at the Middlesbrough furnaces, but 15s. 9d. will be accepted for prompt delivery. The East Hedleyhope Colliery, near Tow Law, which has been idle for eighteen months, is to be reopened in January, but for a time only one of the seams will be worked. Messrs. Bell Brothers are about to sink a new colliery at Bowburn, near Coxhoe, and the shaft will be put down 105 fathoms to the Busty seam.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been great activity in the pig iron warrant market since last report, a very large quantity of warrants having changed hands. Prices have naturally fluctuated to some extent. It is reported that large purchases have been made both by speculators and on the part of consumers for future delivery. The transactions have been of such a nature as to indicate that a large trade is looked forward to in the new year. At the same time there is not much change in the position of the manufacturing branches, and the volume of the shipping trade, in raw iron particularly, cannot be described as very satisfactory.

Rumours are current that iron may be wanted on American account, but so far as can be ascertained, little or no business of this description has actually been done.

Business has been done in Cleveland warrants this week at 52s. 2d. to 53s. 4d. cash, 53s. 4d. for delivery in twenty-one days, and 53s. 6d. to 53s. 8d. one month. Scotch warrants are quoted 58s., and Cumberland hematite 69s. 6d. to 69s. 9d., standard foundry pig iron being at 52s. 3d. per ton.

An additional furnace has been put on ordinary pig iron, and there are now 35 making ordinary, 49 hematite, and 6 basic iron, the total of 90 thus blowing in Scotland comparing with 85 at this time last year.

The prices of Scotch makers' iron are generally steady. G.M.B., No. 1, is quoted at Glasgow 62s.; No. 3, 59s. 6d.; Carnbroe, No. 1, 65s.; No. 3, 62s.; Clyde and Calder, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Gartsherrie, No. 1, 68s.; No. 3, 63s.; Summerlee and Langloan, Nos. 1, 70s.; Nos. 3, 65s.; Coltness, No. 1, 76s.; No. 3, 66s.; Glengarnock at Ardrossan or Troon, No. 1, 68s.; No. 3, 63s.; Eglinton at Ardrossan or Troon, No. 1, 62s. 6d.; No. 3, 60s.; Dalmellington at Ayr, No. 1, 65s.; No. 3, 60s.; Shotts at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d.; Carron at Grangemouth, No. 1, 70s.; No. 3, 65s. per ton.

The shipments of pig iron from Scottish ports in the past week were comparatively small, amounting to only 3974 tons, compared with 5476 in the corresponding week of last year. There was despatched to Canada 79 tons; South America, 300; India, 225; Australia, 347; France, 20; Italy, 20; Germany, 60; Holland, 180; Spain and Portugal, 10; China and Japan, 200; other countries, 235; the coastwise shipments being 2238 tons, compared with 3336 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth amounted to 14,023 tons, against 9732 in the corresponding week, showing an increase of 4291 tons. The total imports since the beginning of the year are now 441,565 tons, being only 2087 tons less than in the corresponding period of 1904.

There is a large consumption of hematite pig iron, but the

supply appears to be quite equal to all requirements. In the last few days the inquiry for Cumberland hematite has been comparatively small, and new business placed for Scotch hematite has been moderate. The latter class of iron is now 1s. below the highest point, merchants quoting 74s. per ton for delivery at the West of Scotland steel works.

The finished iron trade continues well employed, and the outlook is fairly satisfactory. Orders for the future do not seem to be coming to hand in such large quantities, but there is no reason to complain of the general position of business.

The accountant of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board reports that an examination of the employers' books for September and October last shows that the average net prices of finished iron at the works was £5 17s. 7·78d. Under the sliding scale this price entitles the workmen to an advance of 2½ per cent. in their wages, and the increase will be paid to them accordingly.

The engineering, boilermaking, brassfounding, and cognate trades are getting very busy, and the improvement in the tube trade continues. As a result of this improvement, tube works which have been closed for some time are being re-opened. The interchange of capital reported as having been made between Cammell, Laird and Co., of Sheffield and Birkenhead, John Brown and Co., of Sheffield and Clydebank, and the Fairfield Shipbuilding and Engineering Company, of Govan, is an event which is generally regarded as likely still further to increase the activity that prevails on the Clyde. Another development of importance is being made by Messrs. Beardmore, of Glasgow, who are laying down plant for the forging and manufacture of all types and sizes of guns. It is understood that special attention will be given in this new branch to the production of the finest class of naval guns, such as will be required for the warships now building at the firm's Dalmuir shipyard, Glasgow.

A number of fresh shipbuilding orders are intimated, including two steamers placed with Messrs. Scott, of Greenock, for the coasting trade of Messrs. G. and J. Burns, Glasgow.

The volume of business in the coal trade is fairly well maintained. While the shipments have fallen off to some extent, there is greater activity in the home branches. Household coals have been selling briskly in the last few days owing to cold weather, and the requirements of manufacturers are on an extensive scale. Main coal is quoted, f.o.b. at Glasgow, 7s. 9d.; ell, 8s. 3d. to 8s. 9d.; steam, 8s. 6d. to 8s. 9d.; and splint, 9s. 3d. to 9s. 6d. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

FURTHER exhaustive discussions have taken place in connection with the coal negotiations between owners and workmen, and the point left off at on the eve of my despatch was the vexed question of the minimum. "Mabon," in summing up for the workmen's side, disputed the statement that sales were taking place below the 11s. 10d. —the present equivalent of the minimum—but, said he, commenting on this, if owners cannot get 11s. 10d., let the collieries remain idle rather than give up the security of wages enjoyed by the men.

Generally regarded, the discussion is being carried on amicably, and promises to end satisfactorily, especially in view of depressed trade, and with a million tons of coal on the sidings. Briefly stated, the situation is thus summarised :—The coalowners ask for 5d. per ton advantage on the minimum, and the colliers want 6d. for small. One critic pointedly suggests that to settle it, better leave the situation as it is.

As showing the depressed state of the coal trade, I hear of colliers working two days a week in many quarters. Last Saturday, when clearances are generally large, only 45,000 tons left Cardiff. Monday, again, the export was limited to 35,000 tons, out of fourteen steamers seven going to France. On Tuesday, again, only fifteen vessels left, and two of these in ballast, and the total just exceeded 38,000 tons. Considering the output of the large collieries, it is evident that the congestion is increasing instead of diminishing, yet, if prompt sales show weakness in prices, forward bookings are firm, and quotations remain much about last week's figures. The stormy weather has had a great deal to do with the state of trade, delaying tonnage considerably just when business showed a little improvement. The year is going out with a great loss in wrecks and disasters. To the Bavarian, a fine Glasgow boat, with one of the ablest captains in the coal trade, must now be added another loss of a boat, the Carlo, also efficiently manned by a Cardiff captain and crew.

Welsh collieries and their possibilities continue to attract the attention of the London world. Cwmtwrch Colliery, which has been closed for two years, is to be restarted by a London syndicate with latest machinery. Another old colliery, Cwmllyn, is to be reworked by a Llanelly syndicate. At Cefn Gyfelech the 3ft. seam has been won, and I note movements in the anthracite coalfields which, in connection with railway enterprise, promise improvements in the spring.

At the Upper Bank Colliery, Swansea, there was a narrow escape from another Tynewydd. Owing to an inundation, 150 lives were in peril.

On 'Change, Cardiff, this week, a prominent subject of discussion has been the probabilities of a repeal of the coal tax.

Latest quotations : Best steam, 12s. 3d. to 12s. 6d.; best seconds, 11s. 9d. to 12s.; seconds, 11s. 6d.; drys, 11s. to 11s. 3d.; best smalls, 8s. to 8s. 3d.; best ordinaries, 7s. 6d. to 7s. 9d.; seconds, 7s. 3d. to 7s. 6d.; inferiors, from 6s. 9d. Monmouthshire semi-bituminous, best large, 11s. 9d.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d. House coal, best, 16s. to 16s. 6d.; best ordinaries, 13s. 6d. to 15s.; seconds and other sorts, 10s. 6d. to 11s.; No. 3 Rhondda, 13s. 6d. to 13s. 9d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 9d.; No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 6d. to 8s. 9d.; small, 7s. 6d. to 7s. 9d. Patent fuel, 13s. 3d. to 13s. 6d. Coke, 16s. 6d. to 17s., and 18s. 6d. to 22s. Pitwood is still firm at 21s. 6d. to 22s. Freights hardening for the coast.

At Swansea, anthracite more brisk ; steam, 12s. 6d. to 13s.; No. 3 Rhondda, 13s. 6d. to 14s.; drys weaker ; best malting, 19s.; seconds, 16s. to 17s.; big vein, 13s. 3d. to 13s. 9d.; red, 9s. to 10s. 6d.; cobbles, 17s.; nuts, 17s. 6d. to 18s. 6d.; peas, 10s. 6d. to 11s.; culm, 5s. 3d. to 5s. 6d.; duff, 3s. to 3s. 6d. Patent fuel, trade slack, but tonnage expected ; latest price, 11s. 6d. Coal export last week limited to 46,658 tons, and patent fuel down to 2310 tons, on account of storms.

The Germans are reported to be underselling Welsh coalowners in France, and in small the contest is keen. There is not much animation in the iron and steel trade. One noteworthy cargo of rails, 1800 tons, left Cardiff for Colombo, Madras and Calcutta. Pig iron has been coming in freely from Middlesbrough, Harrington and Grimsby, and exceptionally large consignments of ore from Bilbao to the leading works. It is stated at Dowlais that the alterations taking place, such as the erection of new standards for the rolls and other improvements, are preliminary to a larger make of steel rails. The Bessemer department has not been active of late. Siemens and blast furnaces average make. Blaenavon and Ebbw Vale are busy with ore imports, &c. In the Swansea district there is a start to be made shortly with additional blast furnaces, one stated to be capable of turning out 2000 tons weekly. Steel trade in the valley is brisk, and the condition of things in the tin-plate works is satisfactory. It is commented upon on 'Change that so good have been the results in machinery improvement and equipment that the returns of half-a-dozen mills last week were equal to those of ten usually produced when the make was restricted. All industries are showing good results ; spiegel, copper and nickel silver are quite brisk. With respect to the last-named, increased make is regarded as certain. Some optimists are discussing the likelihood of a nickel coinage.

The issue of quotations, Swansea Exchange, continues to be restricted. This week pig iron was as follows :—Middlesbrough, 53s.; Welsh make, 72s. 6d.; Bessemer mixed numbers, 69s. 9d.; Scotch, 58s. Steel bars : Siemens, £5 2s. 6d. to £5 5s.; Bessemer, £5 to £5 2s. 6d. Tin-plates : Bessemer, 13s. 3d. to 13s. 6d.; Siemens, 13s. 6d. to 13s. 9d.; odd sizes, Siemens, 14s.; Bessemer I.C. 28 by 20 by 112 sheets, 26s. 9d. to 27s. 3d. Siemens I.C. 28 by 20 by 112 sheets, 26s. 10½d.; ditto 20 by 10 by 225 sheets, 18s. 9d.; C.A. roofing sheets, Bessemer, £10 per ton ; finished black plates, Bessemer, £10 5s. to £10 10s.; block tin, £155 5s.; lead, £16 ; copper £78 15s.; silver, 30¼ ; spelter, £28 15s.

On 'Change it was stated that the cost of the tin-plate manufacture is still upwards, and the quoted prices are unprofitable to makers. Position of the steel trade is very firmly maintained, and the prospect of an early advance in price of American and German steel considered to be certain, and hence competition in those quarters is not anticipated.

On the whole, notwithstanding decline on Russian business, prospects are good. Shipments last week were only 20,924 boxes ; receipt from works, 60,410 boxes ; stocks, 198,138 boxes. Iron ore 17s. 6d. to 18s.

NOTES FROM GERMANY.

(From our own Correspondent.)

A FURTHER rise in price and a steadily improving activity in most branches of the Rhenish-Westphalian iron industry are reported this week. As the improvement is somewhat slow, but very steady, there is reason to expect it shortly to increase, and a hopeful feeling prevails generally.

For raw iron, both home and foreign inquiries have been active during the week. The blast furnace works have raised their output considerably, and several furnaces that had been blown out are again in blast. In semi-finished steel the business recently done has been better than for years past, and existing orders ensure brisk employment all through the first quarter of the coming year. The Steel Convention has officially announced that for all orders exceeding normal requirements prices will be advanced M. 5 p.t. Scrap iron shows more strength than previously, and quotations have been moving in an upward direction. Sectional iron and rails are in good demand for home as well as foreign consumption, and somewhat better prices could be obtained recently from foreign purchasers. The condition of the bar trade has been a trifle less satisfactory than previously, both producers and dealers exhibiting an inclination to move downwards with their prices at a recent tendering for steel bars. Hoops meet with good request, and realise fair prices. The plate trade is sound and strong, with bright prospects for future employment. Most mills are well provided with work till far into next year. Prices are rather fluctuating, especially those for heavy plates. At a general meeting of the German wire nail works, good employment was stated to prevail at the Convention works, owing to the rise in quotations for wire rods ; an advance in prices for wire nails is being taken into consideration. In hardware employment and demand are lively, and increasing from week to week, foreign inquiry being particularly brisk.

The iron and steel works in the Siegerland are well employed, and are expecting an active trade to be done in the next few months. Dealers purchase freely.

In Silesia a favourable tone prevails in the iron and steel industry. Pig iron sells freely, and the malleable iron department is also well employed ; girders are a trifle dull, but plates show much strength.

Coal is in good demand on the Silesian market, home and foreign requirements increasing. Deliveries to the North Vienna station were stopped last week, to the advantage of inland consumers. The strike in the Ostrau district threatens to spread over the adjoining districts, and this has caused a further increase in demand, dealers and consumers in Silesia being anxious to fill their stores as quickly and as amply as possible. A rise in prices must sooner or later take place ; at present much stiffness is shown in quotations, also in the coke trade, which was vigorously employed all through last week.

The position of the coal market in Rheinland-Westphalia is much the same as in Silesia. To the want of wagons, which is hampering the coal trade very much, there has been added an uneasy feeling about the threatening strike of the colliers, and some pits are already reported to have stopped deliveries in coal, and are largely filling their stores so as to be able to meet the calamity when it comes. Coal for coke making was raised M. 1 p.t. Sales of the Rhenish-Westphalian Coal Syndicate in October of present year have been 4,955,459 t., or 190,595 t. per working day. This shows an increase of 85,383 t., or 1·75 per cent., against October last year.

A normal trade was done in the Austro-Hungarian iron industry during the week now past, and sales generally are about the same as in the corresponding period last year. Pig iron is firm, and a steady trade continues to be done in the manufactured iron department ; only girders and bars are in small request at present. Heavy plates and sheets meet with fair request, and the business in pipes shows fair life.

Though the strike of the railway workpeople in the Bohemian brown coal district has, officially, come to an end, trouble and stoppages have been caused by the inability of the pits to bring their deliveries to a normal amount ; from all districts a shortness of coal wagons is being reported, and some pits are only worked three to four hours per day. Deliveries in brown coal on the Saxon railways were 80,833 t. from the 5th to the 11th of November, which is 7719 t. less than during the same period last year.

A very animated business is reported to have been done in iron and steel on the Belgian market ; prices are still moving further upwards. Though engaged to their fullest capacity, the blast-furnace works can hardly satisfy the demand of consumers.

Coal, too, is firm, and brisk of sale in Belgium.

From the French iron industry good accounts are likewise received, the mills and forges being well engaged, especially in the Meurthe-et-Moselle district, and prices, generally, tend upwards.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 15th.

THE most important feature of the steel market at present is the volume of business that is coming in from the railroad companies. Among the recent purchases made was 30,000 tons by the Oregon Railway and Construction Company, 11,000 tons by the Philadelphia and Reading, 9000 tons by the Detroit and Bay City traction line, and a number of other contracts, aggregating somewhere in the direction of 100,000 tons, an accurate estimate being impossible. Prices for light rails have been advanced 1 dol. per ton, and spikes have been raised to a basis of 2 dols. for 100 lb. There is a renewal of activity in structural material. Much of the demand now pending is for material for the construction of office buildings, large stores, terminal improvements, and engineering plants. Banking concerns are also enlarging their capacity, and many new bank buildings are projected, and which will be erected this winter, iron and steel being the main material used. There are inquiries in hand to-day for about 60,000 tons of structural and fabricated material, all of the inquiries coming from railroad companies who intend to build bridges, terminal improvements, and elevated track work. The activity in pig iron still continues, and furnaces everywhere have opportunities presented to secure business for delivery next summer. Notwithstanding the strong upward tendency in prices, the furnace companies are willing to accept business at the recent advances made. Basic and Bessemer are in very urgent request, and all kinds of foundry, especially No. 2, are being contracted for. At the rate of progress there will be very little stock left unsold for the requirements of the country at the end of this year for the next six months of 1906. The pipe line builders are heavy buyers of pig iron, and the engineering plants are crowding in their orders for special brands of pig which they must have.

The copper market is quite active and the bulk of the available stock is held in strong hands. November exports will be much less than the average, and the demand for January is not at present very promising. There is a temporary activity among small domestic buyers ; exporters took a moderate amount of electrolytic for export during January. The bulk of business has been done on a basis of 16·50 dols. for electrolytic. During the first nine days of November exports were 4634 tons. The falling off in November will probably prevent the exports of this year from exceeding those of last year. Domestic melting is figured out at the rate of 22,000 tons per month. A slight accumulation is now in progress. China has fallen off, though there may be considerable copper sold for shipment, but it will be stored. Stocks there are held in strong hands. Tin has been steadily advancing during the past week, sales of spot having been made at 33 to 33·25 on 5 and 10-ton lots. During the week 660 tons were received in this city. The demand for lead is strong and the St. Louis market has advanced prices to 5·20 spot.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market, owing to the scarcity of tonnage on account of rough weather, keeps dull. House coal remains unchanged. The quantity of coal shipped for the week ending November 25th was 78,140 tons ; foreign, 65,303 tons ; coastwise, 12,837 tons. Imports for the week ending November 28th were :—Iron ore, 10,170 tons ; pig iron, 2120 tons ; phosphates, 168 tons ; scrap, 250 tons ; deals, 610 loads ; pitwood, 3457 loads.

Coal :—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 3d. to 10s. 6d.; house coal, best, 14s.; dock screenings, 7s. 9d. to 8s.; colliery small, 7s. 3d. to 7s. 6d.; smiths' coal, 9s. Pig iron : Middlesbrough, No. 3, 52s. 7½d. ; Middlesbrough hematite, 69s. 4½d. f.o.b. Cumberland, prompt. Iron ore :—Rubio, 17s. 6d. to 18s. Steel :—Rails, heavy sections, £5 10s. to £5 15s.; light ditto, £6 10s. to £6 15s.; Bessemer steel tin-plate bars, £5 to £5 2s. 6d.; Siemens steel tin-plate bars, £5 2s. 6d. to £5 5s. Tin-plates :—Bessemer steel, coke, 13s. to 13s. 3d.; Siemens, coke finish, 13s. 3d. to 13s. 6d. Pitwood, 21s. 6d. ex ship. London Exchange telegrams :—Copper, £78 10s. to £78 15s. ; Straits tin, £155 10s. to £155 17s. 6d. Freights quick, rates firm.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—Meeting at St. Bride's Institute, Bride-lane, Fleet-street, E.C., on Wednesday, December 13th, at 8 p.m. A paper will be read by Mr. J. W. Blakey, on "High-pressure Gas Illumination." Mr. F. W. Goodenough, in the chair.

CONTRACTS.—We are informed that Messrs. Lassen and Hjort, of 52, Queen Victoria-street, E.C., have received orders for water-softening plants from the following firms :—Messrs. Joseph Rank, Limited ; Royal Arsenal Chemical Research Department, Woolwich ; Bell's Asbestos Company, Limited ; Siemens Bros. and Co., Limited ; Italian Admiralty Naval Construction Department ; James Booth and Co., Limited ; J. B. Lawes and Co., Limited ; Ruston, Proctor and Co., Limited ; Antofagasta and Bolivia Railway Company, Limited ; Mark Mayhew, Limited ; and the Great Southern of Spain Railway Company, Limited.

WINTER SEASON ON THE ENGADINE.—Special arrangements are being made this year for the comfort and convenience of those wishing to travel to the Engadine. A new *train de luxe* service, composed exclusively of dining and sleeping cars, will run from Calais direct to the Engadine, without change of carriage, every Tuesday and Friday in December, January, and February. This train will run in connection with the turbine steamer service—train leaving Victoria and Holborn stations at 11 a.m.—and the Channel passage between Dover and Calais will be made in about sixty minutes. Only first-class passengers will be taken by this train, which will arrive at Davos Platz in twenty-four hours and at St. Moritz in twenty-six hours from London.

EARLY CLYDE ENGINES.—Mr. James Mollison, chief engineer-surveyor to Lloyd's Register at Glasgow, calls attention in the columns of the *Glasgow Herald* to the unprotected position in which a number of highly interesting relics of early Clyde engines, both land and marine, are kept in Kelvingrove Park, and to the deterioration which is going on rapidly, and which, if not arrested by careful painting and by covering in the items with light housing, will greatly reduce their value and interest as typical examples of early engineering. The largest of these relics is a very good specimen of the overhead beam engine, as produced by Boulton and Watt, formerly at work in the East End of Glasgow. There are also two marine engines, each having come out of a notable early Clyde steamer. The larger of these was constructed in 1828, by Caird and Company, at Greenock, and formed the second engine fitted into the steamer Industry, built by Fyfe, of Fairlie, in 1814, and engined originally by George Dobbie, of Tradeston, Glasgow. The smaller engine is believed to be the engine of the second Comet, built in 1821, and is understood to have been recovered from the wreck of that vessel after the disastrous collision between it and the Ayr, off Gourock, in October, 1825, subsequently doing duty for many years at a printing warehouse in the neighbourhood of Buchanan-street, Glasgow. These sets are probably, says Mr. Mollison, the only specimens now existing of the designs and workmanship produced in the early days of a business, in the development and improvement of which the Clyde has all along held the premier position. The writer also refers to the fact that there is still working at Farme Colliery, near Rutherglen, an atmospheric or Newcomen engine, erected in 1809, and similar in all respects to those in use at the time when Watt made his great innovation by introducing the separate condenser. It is hoped that this other example may find a suitable place alongside those referred to when the proprietors of the colliery think of discontinuing its use.

IMPORTANT COMBINATION.—A combination of exceptional interest in the manufacturing world is announced. Messrs. Cammell, Laird and Co., Limited, Cyclops Steel and Ironworks, Sheffield, have acquired by purchase one-half the ordinary share capital in the Fairfield Shipbuilding and Engineering Company, Limited, of Govan. The Fairfield Company have acquired by purchase a number of shares in Cammell, Laird and Co., Limited, as well as a portion of the shares in the Coventry Ordnance Works, Limited. The other proprietors of the Coventry Ordnance Works are Messrs. Cammell, Laird and Co., Limited, and Messrs. John Brown and Co., Limited, Atlas Steel and Ironworks, Sheffield. The present arrangement is the latest development of a tendency which has been decidedly manifest recently towards combination throughout the iron and steel industries and kindred trades. By this amalgamation of interests, the Fairfield Company is associated with the well-known Sheffield firm for armour and with the Ordnance Works at Coventry for guns, thus bringing it into line with the other leading establishments in its ability to build and equip warships within its own and allied resources. The advantages to Messrs. Cammell, Laird and Co. of the "combine" are obvious, for the Fairfield Company has a great name in the shipbuilding world. It was the cradle of the Atlantic greyhounds, the first of which was built there, followed by the Umbria and the Etruria, the Campania and the Lucania. Amongst recently-constructed warcraft were the battleship Commonwealth and the first-class armoured cruiser Good Hope. Birkenhead has contributed notably towards the development of the steamship, and has a long record of ships built and engined for the British Admiralty, one of the latest battleships being the Exmouth, of 14,000 tons displacement, and 18,346 indicated horse-power. The union of interests in the two great yards is expected to be extremely beneficial to both and to the companies which own them.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS,** *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

3015B. February 14th, 1905.—IMPROVED FURNACE FIRE-GRATE, *Tozaburo Suzuki*, 401, *Jibeishinden, Sunamura, Tokio, Japan.*

This invention relates to improvements in furnace fire grates of that class, comprising movably mounted, angularly disposed grate sections, to which oscillatory movement is imparted by mechanism on the exterior of the furnaces. There are two figures. Fig. 1 is a longitudinal vertical sectional view. This invention is shown in connection with a type of furnace in which the fuel is first fed into a distilling chamber and is subsequently discharged therefrom upon the fire-grate. The improved grate consists of a number of horisontally disposed grate bars 1 which operate upon ways 2 anchored in any suitable manner to the side walls of the furnace. The grate bars 1 are oscillated by a lever 3, which is pivotally secured at 4 to the outer front wall of the furnace, and is connected with the grate 1 by a link 5. In the preferred form the grate bars 1 do not extend throughout the entire depth of the combustion chamber, but are supplemented by an extension 6, which is desirably inclined with respect to the bars 1. The inclined bars 6 are mounted at their upper ends upon metallic

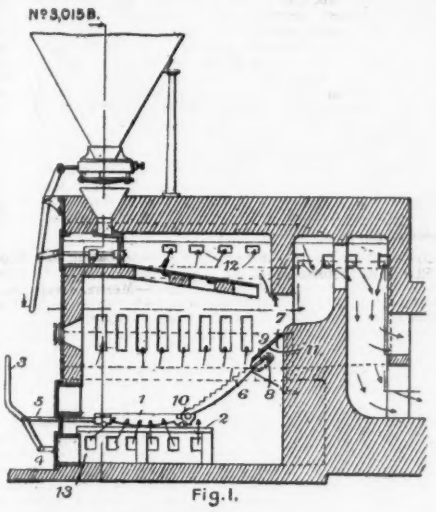
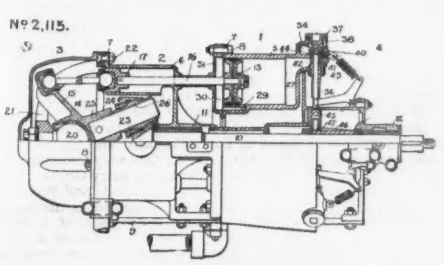


Fig. 1.

brackets 7, the latter having trunnions 8 adapted to engage slots 9 formed on the outer ends of the grate 6. The slots are of sufficient length to permit the bars 1 and 6 to be reciprocated in forward and rearward directions to their extreme limits of movement. The inclined bars 6 are pivotally secured to the bars 1, and are provided with an overlapping grate bar 10 which prevents fuel from clogging the pivotal joint. As the lever 3 is moved toward and away from the furnace, a uniform reciprocation of the grates 1 and 6 will be effected. The brackets 7 are provided with a protecting apron 11, which extends forwardly some distance over the trunnion and slot connection of the inclined grate 6 with the brackets 7. The apron 11 is in direct vertical alignment with the outlet of the distilling chamber 12, and that apron therefore receives the discharged fuel direct from the distilling chamber and deflects the fuel directly upon the grate, thereby effectively protecting the slot and trunnion connection.—*November 1st*, 1905.

2115. February 2nd, 1905.—IMPROVEMENTS IN AND RELATING TO RECIPROCATING FLUID-PRESSURE ENGINES, The British Thomson-Houston Company, Limited, 83, Cannon-street, London.—*A communication from the General Electric Company of Schenectady, Schenectady, New York, U.S.A.*

This invention relates more particularly to valve mechanisms for controlling the admission of motive fluid to the cylinders, and its object is to improve the general construction of valve mechanisms, so as to render the valve or valves more accessible for removal and repair. The invention is shown applied to an engine of the wabbler type, the shaft being parallel with the cylinder axis. There is one figure—a sectional elevation. The engine is constructed in sections. 1 is the cylinder section, 2 the crosshead section, 3 the crank or wabbler section, and 4 the section containing the cam or cams for operating the valves. The cylinder section comprises a plurality of parallel cylinders 5, arranged symmetrically around a common axis, and is preferably, although not necessarily, a single casting. The crosshead section 2 is also a single casting,

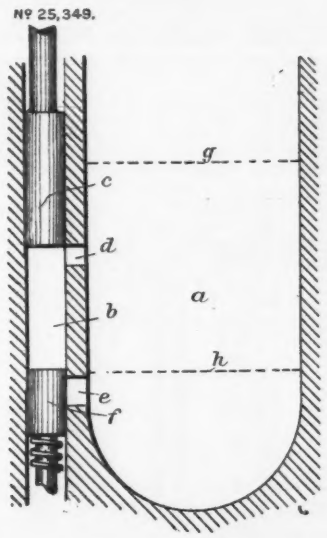


and comprises cylinders 6, which are arranged similarly to the piston containing cylinders, and axially align therewith. The several sections are bolted together, and for this purpose they are provided with circumferential flanges 7 at their ends, which receive the securing bolts 8. The sections may be further secured by side bars 9, which are suitably bolted to the sections. Extending centrally through the sections 1, 2, and 4, and disposed parallel to the axes of the cylinders, is a crank shaft 10, which is mounted in bearings 11 and 12 provided in the crosshead section and the cam section respectively. The pistons 13 reciprocate in a direction parallel to the axis of the shaft 10, and their rectilinear motion is translated in rotary motion of the shaft by means of a wabbler 14. The wabbler is provided with as many arms 15 as there are pistons, and the latter are each connected with an arm by means of a piston-rod 16, a crosshead 17, and a connecting-rod 18. Each arm receives an oscillatory movement from its respective piston, and is connected with its crosshead and wabbler arm by a ball-and-socket joint. To provide for this movement, the wabbler is mounted upon a central bearing, which is preferably a ball 20. This is carried by a skeleton-shaped frame 21, secured by bolts 22. The movement of the wabbler is changed into continuous rotation of the crank shaft 10 by means of a crank pin 23 and a crank arm 24. The pin is secured at one end in the hub 25 of the wabbler. A ball-and-socket joint 26 is provided between the arm and the pin, so as to permit the latter to turn in the arm as they both revolve together. The exhaust from the cylinder discharges through exhaust ports 29 into an annular exhaust chamber 30, which is cored out in the plate 31. Communication between the admission chamber and the clearance space 27 of each cylinder is controlled by an outwardly opening valve 34. The valve stem is guided in a sleeve 36, which is removably secured to the admission chamber, and projects inwardly towards the crank shaft. Arranged in line with each valve is a removable plug or cap 37, which screws into a threaded opening 38 in the wall of the valve chamber. The end of the sleeve in the admission chamber is provided with an annular shoulder 40, which is finished to form the seat for the valve. The end is also counterbored to a certain depth, to provide a space around the valve stem that connects with ports 41 in the sleeve and the passage 42 communicating with the clearance space of the cylinder, and through which the motive fluid passes to the latter. The sleeve is firmly secured in position by means of a nut 43, which screws against the inner wall of the admission chamber. The flange or shoulder 40 at the seat end of the sleeve is held firmly in place upon an interior flange 44 in the admission chamber. The tappets 45 are arranged in the cam section 4, and receive motion from a cam 46 that is adjustable on the crank shaft. Anti-friction rollers 47 are provided on the tappets. To vary the lift of the valves and the point of cut-off, the cam may be adjusted axially.—*November 1st*, 1905.

INTERNAL COMBUSTION ENGINES.

25,349. November 22nd, 1904.—MEANS FOR PRODUCING AND REGULATING SELF-IGNITION OF THE CHARGE IN EXPLOSION OR INTERNAL COMBUSTION ENGINES AND SECURING MORE PERFECT COMBUSTION IN SAME, Arthur E. Beck, Earlswood House, Earlswood, Warwickshire.

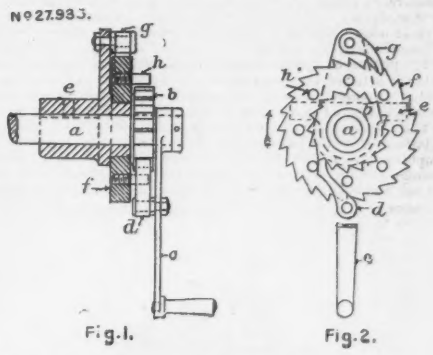
This invention relates to the ignition of the charge in explosion or internal combustion engines, the object being to provide means for the automatic or self-ignition of the said charge, and in such a manner as to ensure more complete combustion and higher working efficiency. It consists in the compression of a combustible gas or mixture to an extent sufficient to produce automatic or self-ignition, and the admission of such ignited mixture to the main or cylinder charge in such a manner as to fire the same rapidly. There is one figure. In communication with the cylinder *a* of a gas engine is arranged the supplementary cylinder *b* within which is a piston or ram *c*. The communication between the main and supplementary cylinders *a* and *b* is effected by way of ports *d* and *e*. The ram *c* is driven from the crank shaft of the engine or otherwise, and is adapted to compress the gas in the cylinder *b* to a much greater extent than that of the compression stroke of the piston working within the latter cylinder. The small cylinder *b* receives its charge from the main cylinder *a* during the suction stroke of the piston within the latter cylinder. The dotted line *g*



represents the extremity of the out-stroke of the main piston and the dotted line *h* the in-stroke. The admission from the cylinder *a* to the cylinder *b* is by way of the port; the admission can be effected whilst the piston travels from the port *d* to the end of the stroke at *g*. During the first part of the compression stroke of the piston in *a* the gas in the cylinder *b*, owing to the cylinder being open to the cylinder *a* by the port *d*, is also subjected to the same compression. But when in the compression stroke of the piston in *a* the port *d* is covered, the ram *c* is set in operation by a cam, and thus imposes a degree of compression on the gas beneath it, which is so much greater than the final compression imposed on the gas in *a* by the compression stroke of the piston therein that the gas in *b* is automatically ignited by the heat resulting from such high compression. On ignition, the further rise of pressure due to the ignition moves the valve *f* against its adjustable spring, and thus permits the ignited compressed gas to flash through the port *e* into the cylinder *a* for detonating the main charge therein.—*November 1st*, 1905.

27,935. December 21st, 1904.—A COMBINED CRANK HANDLE AND DISENGAGING GEAR, Horace E. Baly, Besthorpe, Attleborough, Norfolk.

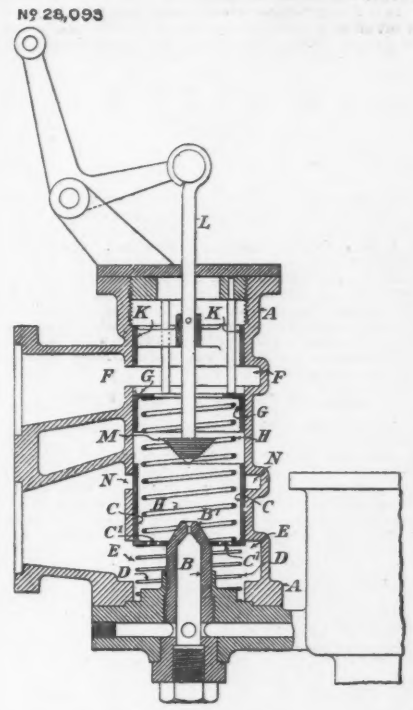
This invention relates to a method of putting out of gear the starting handle used for starting internal combustion engines, so that when a back fire takes place and the engine suddenly runs in a reverse direction the arm or hand of the person starting the engine may not be injured. It can also be applied to stop or put out of gear the handle of cranes or any class of machinery in which, when the crane or machinery is working in a reverse direction, the handle is liable to revolve backwards. There are twelve figures. Fig. 1 is an elevation partly in section, and Fig. 2 is a front view; *a* is the starting shaft, *b* a ratchet wheel fixed on shaft, *c* a starting handle loose on shaft, *d* a pawl pivoted on handle *c*, *e* the main casting for supporting the mechanism, *f* a loose plate with teeth on its periphery and projections or pins *h* on its face; *g* is a pawl pivoted on bearing casting *e*, and engages with the ratchet plate *f*, so that *f* can only travel in direction of arrow. The operation is as follows:—When the handle *c* rotates the pawl *d* revolves the ratchet wheel *b*, and at the same time the loose plate *f*, the latter by the projections *h*; but should a back fire take place the loose plate *f* cannot return, being stopped by the pawl *g*, so



that the pawl *d* is forced out of the ratchet wheel *b* by coming in contact with projection *h* behind it.—*November 1st*, 1905.

28,093. December 22nd, 1904.—IMPROVEMENTS IN OR CONNECTED WITH CARBURETTERS FOR INTERNAL COMBUSTION ENGINES, AND THE LIKE, The Mo-Car Syndicate, Limited, and John S. Napier, Underwood, Paisley.

The object of this invention is to construct an improved form of carburetting apparatus by which an automatic regulation of the mixture suitable for varying speeds of the motor may be attained, automatic governing effected, and the cylinders of the motor placed in communication with the air when desired while cutting off the supply of spirit. There is one figure, a vertical section. A is a cylindrically bored casing, from the base of which a spirit supply nozzle B projects, formed with an upper conical termination B^1. A hollow cylindrical piston controlling valve C, having a projecting base flange C^1, is fitted within the lower part of the casing, and is normally supported by a spring D, so that the flange C^1, which fits closely around the nozzle B, lies level with the base of its conical termination B^1. The flange is perforated, and an air way E is formed below it in the base of the casing. In action at starting the motor, the suction will draw air through the perforations in the



flange C^1 and suck a proportionally large supply of spirit from the nozzle B. Increased suction due to higher speeds will cause the controlling valve C to lift proportionately, and as the central bore of the flange C^1 rises above the base of the nozzle B^1 an increasingly large passage for the air will be produced. The governing is effected by a downward movement of the throttle, which may be automatically controlled by a connection with the governor. To place the cylinders of the engine in direct communication with the air the throttle valve K is depressed by means of a hand or foot operated connection so as to pass the induction passage F and carry the floating washer G down, and the latter in acting through the medium of the compression spring H depresses the controlling valve C below the air flushing way N, while the apex of the spraying plate M closes the spirit outlet.—*November 1st*, 1905.

29,031. December 30th, 1904.—IMPROVEMENTS IN OIL OR GAS ENGINES, Edmund Edwards, The Elms, Strand-on-the-Green, Chiswick.

This invention relates to two-stroke cycle engines. In a cylinder of two diameters the smaller is used as a pump and the larger as the working cylinder. Openings are made from the interior of the hollow piston which communicate with the annular space in the lower cylinder at the bottom of the stroke, and allow air compressed into the crank chamber during the down stroke to pass through them into the annular space, and thus aid in expelling the used gases through the exhaust. The use of the larger lower piston enables a comparatively high degree of compression of the air drawn into the crank chamber to be obtained. The upper smaller piston is used to draw in at its down stroke air only instead of a combustible mixture of air and gas or vapour, and when this air has been compressed during the up stroke through the valve in the cover into the passage between the upper parts of the two cylinders, a small quantity of gas or inflammable oil in the form of spray is forced into the upper part of the volume of compressed air, and as the down stroke commences this inflammable spray or gas is ignited, together with the air with which it mixes, so as to obtain by expansion the necessary increased pressure upon the top of the lower annular part of the piston. There are thirteen figures. Fig. 2 is a vertical section through the engine. The cylinder has two different diameters, the area of the upper one being about half the area of the lower one, whilst the hollow piston *c* also has two corresponding diameters corresponding with and fitting in the cylinders. In the hollow piston *c* is pivoted the

connecting-rod *d*, fitted upon a crank formed upon the shaft *f*, and revolving in the hollow air-tight chamber *g* upon which the main cylinder is fixed. The crank shaft revolves in bearings *h* h^1 in perforated plates *i* i^1, which are fitted and fixed in the ends of the chamber *g*. India-rubber or like valves *j* allow the air to be drawn into the chamber *g* through the perforated plates *i* i^1 by the piston as it rises, and this air is compressed as the piston descends, the amount of compression being considerable on account of the larger diameter of the lower part of the piston than of the upper part; *k* is a jacket round the cylinder through which water is made to circulate, and *l* is a cover to the cylinder, through spaces in which the water also circulates, being preferably admitted through the passage from the jacket *k* and discharged through a pipe fitted to an opening. In the cover *l* is an inlet valve *o* through which a regulated mixture of air and oil or gas, supplied through an adjustable valve *p*, is drawn at the down stroke and is forced at the up

No 29,031.

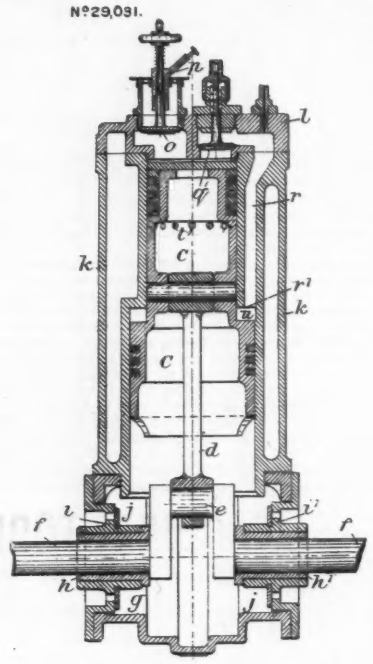


Fig. 2.

stroke through a valve *q* in the cover into a passage *r* communicating with the upper part of the larger lower cylinder at r^1, and an exhaust port is uncovered by the upper edge of the lower part of the piston *c* at the lower part of its stroke. The compressed combustible mixture is ignited by electricity or other well-known means at the commencement of the down stroke of the piston. Openings *t* are made from the interior of the hollow piston, which communicate with the annular space *u* in the lower cylinder at the bottom of the stroke, and allow part of the air compressed into the chamber *g* to pass through them into the space *u* and so drive out the used gases and products of combustion through the exhaust port.—*November 1st*, 1905.

RAILWAYS AND TRAMWAYS

307. January 6th, 1905.—IMPROVEMENTS RELATING TO FLUID-PRESSURE BRAKES, The Westinghouse Brake Company, Limited, and Alan W. Rendell, 82, York-road, King's Cross, London.

It has already been proposed for high-speed train service to employ a main and auxiliary set of brake apparatus on each vehicle, the auxiliary set being brought into use only when the speed of the vehicle is sufficiently high to permit of its employment without danger of skidding the wheels. With this arrangement the brake apparatus is not duplicated throughout, the two brake cylinders being connected to the brake rigging, and operated through a common train pipe. Each brake cylinder is provided with its own triple valve. The object of this invention is to provide means whereby the auxiliary brake cylinder is cut out of operation at ordinary service braking pressures, independently of the speed of the train. There are nine figures. Fig. 1 is a longitudinal section of the valve device for controlling communication between the triple valve and the auxiliary brake cylinder. The valve chamber 1 is in direct communication with the usual brake cylinder port of the auxiliary triple valve by means of a pipe, and the valve seat is provided with a port 5, which communicates with

No 307.

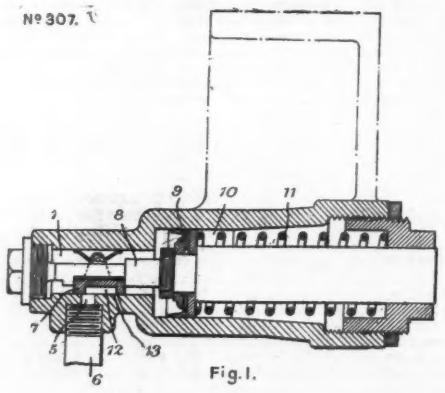


Fig. 1.

the auxiliary brake cylinder by means of a pipe 6. The port 5 is controlled by a slide valve 7, which is operated by a stem 8 of a piston 9, working in a cylinder 10, in unrestricted communication with the valve chamber 1. The piston 9 is subjected to the pressure of a spring 11, whereby the valve 7 is normally held in the position in which communication between the valve chamber 1 and the port 5 is closed. The valve 7 is provided with a cavity 12, which, in the normal position of the valve, affords communication between the port 5 and a port 13 leading to the atmosphere. The pressure of the spring 11 is, in actual practice, so adjusted that only on an emergency application of the brake will the pressure admitted to the valve chamber 1 and cylinder 10 be sufficiently high to move the piston 9 against the pressure of the spring 11, and thus operate the valve 7, so as to open communication between the valve chamber 1 and the port 5 leading to the auxiliary brake cylinder. A small leak hole is provided at some suitable point between the brake cylinder and the port 3, so that the pressure admitted to the brake cylinder can gradually leak off. When the pressure has been so far reduced that the valve 7 is moved back by the spring 11 to the normal position, the port 13 will afford an additional exhaust to the atmosphere. The port 13 allows any leakage past the valve 7 which may occur when the valve is in normal position to blow off to the atmosphere.—*November 1st*, 1905.

MISCELLANEOUS.

1805. January 30th, 1905.—AUTOMOBILE FIRE ENGINES, James Merryweather, Greenwich-road, Greenwich.

The object of this invention is to convert steam fire engines that are arranged for horse draught into automobile vehicles. A framework is used on which is arranged an internal combustion engine and a transmission gear, terminating towards the rear in a pair of toothed sprockets, fixed to a differential shaft running transversely across the framework. The front portion of the framework is mounted on carriage springs and a steering axle. The framework is rigidly attached to the existing steam fire engine arranged for horse draught; the front wheels and fore-carriage of the steam fire engine having first been removed. The toothed sprockets on the framework are made to gear with the gear wheels on the steam fire engine by means of driving chains. There are two figures. Fig. 1 shows a side elevation of a horse-drawn fire engine converted

No 1,805.

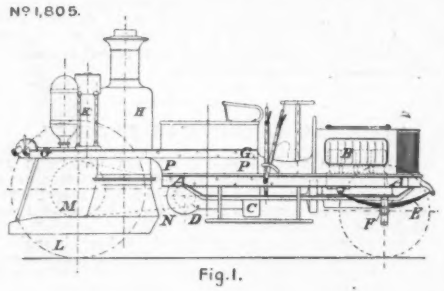


Fig. 1.

into an automobile vehicle. A is a frame work on which is arranged an internal combustion engine B and a transmission gear C terminating towards the rear in a pair of toothed sprockets D D. The front portion of the framework is mounted on springs E and a steering axle F. G are angle steel side bars forming part of the framework of the existing steam fire engine from which the fore-carriage has been removed, which carries a boiler H and engine K mounted on wheels L, to which are attached toothed rings M driven by roller chains N from the sprockets D attached to the framework A. The framework A is attached rigidly to the framework G by means of the brackets P, thus converting the two separate portions of framework each mounted on a pair of wheels, to one four-wheeled automobile vehicle.—*November 1st*, 1905.

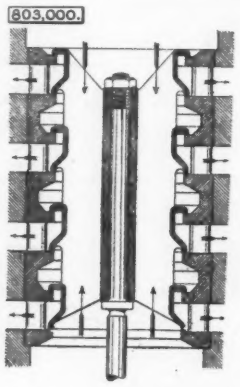
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

803,000. MULTIPLE-SEAT VALVE, *H. Lentz, Berlin, Germany.—Filed March 31st*, 1905.

This patent is for one of the forms of drop valves now much in favour. The single claim runs thus:—In a multiple-seat valve, a valve body having a succession of valves of like diameters,

803,000.

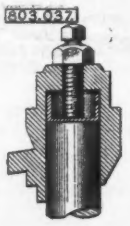


and a valve box wherein said valve body is incased, said valve box being divided into sections axially of the valve and having a succession of valve seats corresponding in number with the valves and all of like diameters.

803,037. CUTTER HEAD, *J. W. Ward and W. A. Williams, Bolton Landing, N.Y.—Filed July 15th*, 1905.

This invention is for an improved means for adjusting "matcher-head" cutters, which consists in combining with the matcher-head spindle and its clamp screw, a cup-shaped washer adapted to be

803,037.

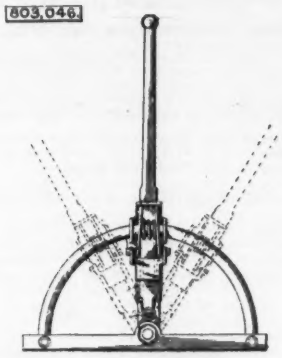


reversibly placed between the screw and spindle, and provided with washers adapted to be independently seated within the cup, which can be interchanged, the washers each having a minor and a major thickness, and having a combined major thickness less than the major thickness of the cup in which they are held.

803,046. SELF-LOCKING LEVER, *G. O. Bjorneby and A. O. Brager, Fertile township, County of Walsh, N.D.—Filed April 19th*, 1905.

According to this invention an arched bar or quadrant is provided on which are threaded two or more plates with springs, which tip them so that they clutch the bar and hold the lever fast until they are tipped in the opposite direction. Perforated clutch

803,046.



plates are used in this way in several varieties of arc lamp. There are seven claims.

803,071. ART OF MAKING CAR WHEELS, *C. T. Schoen, Philadelphia, Pa.—Filed February 28th*, 1905.

Best described by the single claim, for the process of forging car wheels, which consists in subjecting a heated, flat, angular slab or billet of wrought metal to the action of dies and thereby reducing

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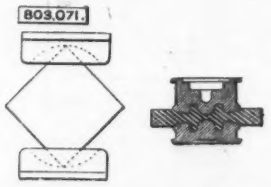
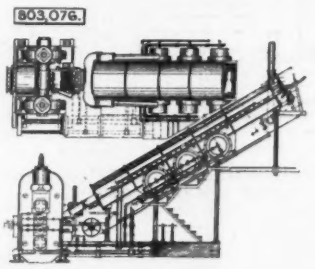


its angles to curves and forming a circular blank, then pressing out the hub and adjacent portions of the web, trimming the rim and finally die-finishing the hub, web and flanged tread.

803,076. FURNACE, *D. M. Somers, New York, N.Y.—Filed October 19th*, 1904.

This patent is for the combination of a furnace with a train of sheet rolls, and is another example of the application of the continuous system now being tried in the United States. There are no fewer than fifty-two claims, covering various details. A main

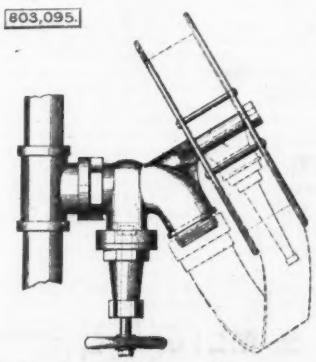
803,076.



object is to maintain a deoxidising gas flame so that scaling shall be prevented while the rolling is in progress, and the sticking together of the sheets will be avoided. To this end a pressure is maintained in the furnace a little greater than that of the external atmosphere, which is thereby excluded. A special conveyor is provided for carrying the sheets through, with arrangements for keeping it cool.

803,095. FIRE-HOSE APPARATUS, *E. Cliff, East Orange, N.J., assignor to Cliff and Guibert Company, New York, N.Y., a Corporation of New York.—Filed May 11th*, 1904.

803,095.



The engraving is self-explanatory. There are four claims.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

THE British Empire Motor Trades Alliance, Limited, has received an inquiry from Geraldine, New Zealand, for light touring motor cars, with two cylinders, to seat four without luggage, or two with luggage, 2ft. clearance under engine for crossing creeks, weight not to exceed 15 cwt., simplicity and reliability essential points. British manufacturers of the above are requested to communicate with J. B. King, secretary, 11, Red Lion-square, W.C.

MR. FRANK R. DURHAM, A.M. Inst. C.E., informs us that, after twelve years' experience under Mr. W. H. Lindley, M. Inst. C.E., F.G.S., of Frankfort-on-the-Maine, in the design and construction of sewerage and waterworks on the Continent, he has returned to England, and proposes in the future to practise as a consulting engineer in all matters concerning sewerage and waterworks. For these purposes he has taken an office at Queen Anne's-chambers, Broadway, Westminster, where all inquiries may be made.

MACHINE TOOL DESIGN.

By Professor J. T. NICOLSON, D.Sc., M. Inst. C.E., and Mr. DEMPSTER SMITH.

No. XIV.*

We now come to arrangements which give not only double or treble, but quadruple gears also. Fig. 55 shows an arrangement similar to Messrs. Shanks', wherein the third motion shaft carries an internally geared wheel, whereby one single, two treble, and two quadruple gears are obtained. The cone and pinions A and C are mounted freely upon, and the wheel and pinion F and G are keyed to, the first motion shaft, F carrying a lock-bolt for the purpose of the single gear drive. I, D, B, and E are keyed to the second motion shaft, and all but the first

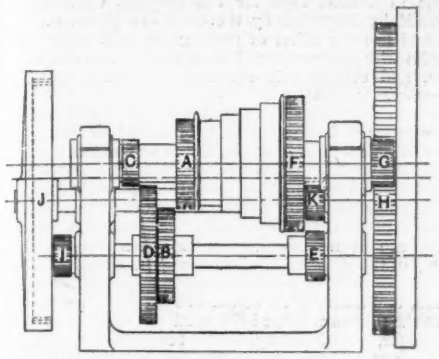


Fig. 55

can slide along it. The third motion shaft—situated between the first and second motion shafts, and at the back of the same—carries the internal wheel J and the pinion K, both of which can slide along it. [When F is larger than the cone end plate, K and J may both be withdrawn at one operation.] We thus have:—Single gear—cone locked to F—G, H; first treble gear, A, B, E, F, G, H; second treble gear, C, D, E, F, G, H; first quadruple gear, A, B, I, J, K, F, G, H; second quadruple gear, C, D, I, J, K, F, G, H. Number of spindle speeds equals $5\ p\ q$.

Fig. 56 shows an arrangement, recently illustrated in

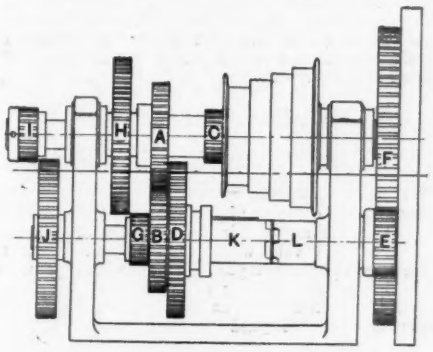


Fig. 56

THE ENGINEER for a 54in. lathe, by Messrs. Hulse and Co., to give two double and two quadruple gears.

The pinions A and C are fast to the cone, and revolve freely on the shaft, the latter being capable of sliding on the same. J, E, and clutch L, are keyed to the second motion shaft, the clutch being free to slide along the same. G and K may be in one piece, and the wheels B and D are keyed together, and to the sleeve K, and are capable of sliding on same. When withdrawing B and D the sleeve K is temporarily locked to the shaft by means of a set screw, and the set screw by which B and D are locked to the sleeve being released, a claw fitted with two

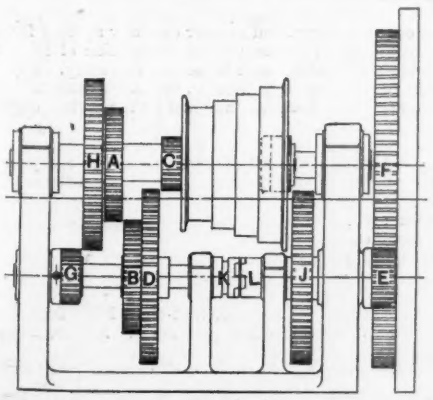


Fig. 57

ferrules, and carried on a rack which is actuated by a hand-wheel and rack pinion, moves B and D in or out of gear. When G is wanted to engage with H, the wheels B and D are withdrawn sufficiently far to enable G to move forward, B and D are then locked to the sleeve by means of the set screw, and the above withdrawing mechanism is used to move G into gear. When running with double gear the pinions I and G are with

* No. XIII. appeared November 24th.

drawn, and the clutch L engaged with K. When using the quadruple gear, the clutch L is withdrawn and the pinions G and I engaged with H and J. First double gear, A, B, E, F; second double gear, C, D, E, F; first quadruple gear, A, B, G, H, I, J, E, F; second quadruple gear, C, D, G, H, I, J, E, F.

In order to keep the length of the headstock down, the wheels I and J—Fig. 56—are outside the bearing, and when the lathe is taking its maximum cut, the greatest torque coming on the second motion shaft and the wheel J being situated at the end of the shaft furthest from the work, requires to be very large in diameter in order to give the necessary stiffness. This can be reduced by bringing the wheel J forward to the front of the headstock, as shown in Fig. 57. As in Fig. 56, the wheels A and C and the cone are fixed together and revolve freely on the shaft, while H and I are keyed to it, I being free to slide on the same. G, B, D and K are keyed to a short shaft, on which they are all free to slide. L, J, and E are keyed to a second

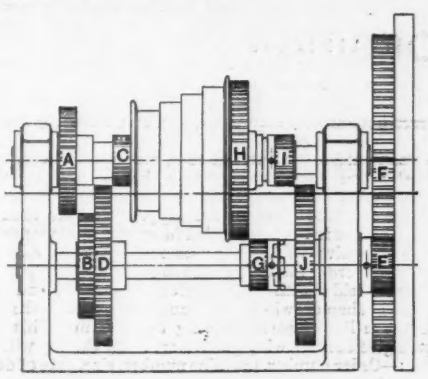


Fig. 58

short shaft on the same axis prolonged as the first-mentioned short shaft. When running double gear the clutch K is moved forward to engage with L; G and I being withdrawn. When running quadruple gear, G and I are engaged, and the clutch K is disengaged from L. First double gear, A, B, E, F; second double gear, C, D, E, F; first quadruple gear, A, B, G, H, I, J, E, F; second quadruple gear, C, D, G, H, I, J, E, F. Some makers object to the short lengths of shaft, as the vertical reaction on the face-plate pinion tends to make the second short shaft bearing bell-mouthed.

Fig. 58 shows a modification of 56 and 57, which also dispenses with the short shafts and long sleeves, the heaviest wheel being close to the face-plate pinion. The cone and wheels A and C may be keyed to the shaft, so that the wear due to them takes place in the bearings where it can be taken up. The wheel H is keyed to the sleeve of the pinion I, and revolves freely on the shaft. It will be clear that the wear due to H, I, is considerably smaller than that due to the cone, as the rubbing speed is only that due to the difference between the cone shaft and gear revolutions, and this wear takes place when using the quadruple gear only. The wheel J is keyed to the sleeve of the pinion E, which is free on the second motion shaft, while B, D, and G are keyed to and are capable of sliding along it. When using the double-pinion gear G, which has a clutch face, is made to engage with the clutch face on the wheel J or pinion

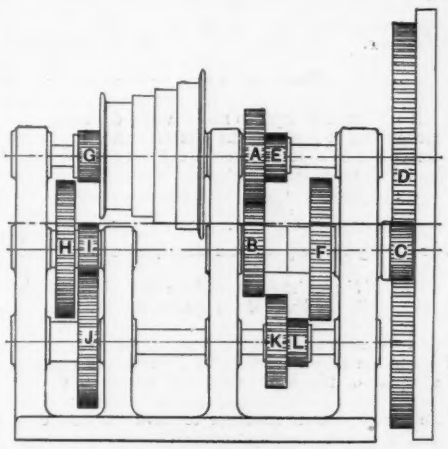


Fig. 59

sleeve E, the wheels H and I being withdrawn, and conversely, when using the quadruple gear. We then have the following drives:—First double gear, A, B, E, F; second double gear C, D, E, F; first quadruple gear, A, B, G, H, I, J, E, F; second quadruple gear, C, D, G, H, I, J, E F.

It is evident that the arrangement shown on Fig. 58 could be made to give three double and two quadruple gears by locking the wheel H with the cone and engaging I with J. This arrangement does not, however, give such a large ratio of maximum to minimum speeds in geometrical progression as is possible with the other. This arises from the necessity of diminishing the ratio of the two gears H, G, and D, C; which must be done to secure a proper geometrical progression of speeds with the second arrangement.

Fig. 59 shows a simple arrangement known as the Whitworth principle, where the cone and all the wheels are keyed to the shafts, and clutches and sleeves dispensed with.

The second motion shaft is in two pieces, and the arrangement permits of two double gears and two quadruple gears, giving a very high maximum ratio of gear. We have:—First double gear, A, B, C, D; second double gear, E, F, C, D; first quadruple gear, G, H, I, J, K, B, C, D; second quadruple gear, G, H, I, J, L, F, C, D.

Fig. 60 shows an arrangement where the cone is brought to the rear of the head, three double and four quadruple gears being obtained. The cone is keyed to the shaft carrying the pinions A, C, and E. A second motion shaft situated behind and above the cone shaft carries the wheels B, F, J, and G; whilst another second

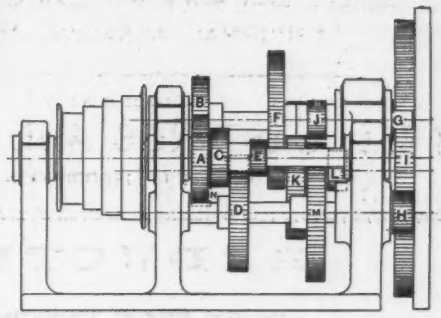


Fig. 60

motion shaft below and behind the cone shaft carries the wheels D, M, and H. Behind and between these two second motion shafts a third shaft is placed, upon which wheels K, L, and N are mounted. The drives then are:—First double gear, A, B, G, I; second double gear, C, D, H, I; third double gear, E, F, G, I; first quadruple gear, A, B, J, K, N, D, H, I; second quadruple gear, A, B, J, K, L, M, H, I; third quadruple gear, E, F, J, K, N, D, H, I; fourth quadruple gear, E, F, J, K, L, M, H, I.

Fig. 61 shows an arrangement by a continental firm

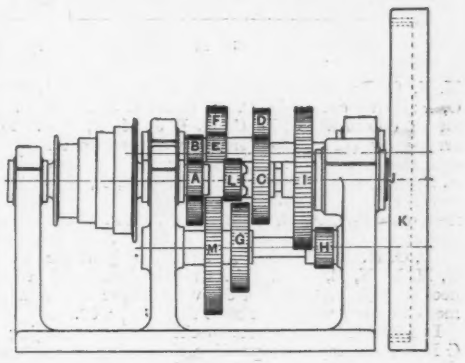


Fig. 61

where the cone and wheel A are keyed to a side shaft; the drive to the spindle being obtained through two or more pairs of wheels, thus giving a high value of R_θ, the ratio of cone to spindle speed when the latter has its highest speed of rotation (N_θ). The first motion shaft which is immediately behind the cone shaft carries the wheels B, L, C, I, and J. On a second motion shaft behind and above the first motion shaft are keyed the wheels E and D, while another second motion shaft below the former carries the wheels M, G, and H. On the spindle is keyed the wheel F. B and L are coupled

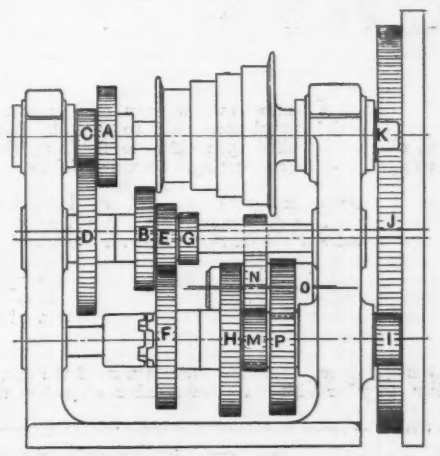


Fig. 62

together and rotate freely on the shaft, while C is keyed to it, and has a clutch face which engages with a corresponding face on L. G and H are keyed to their shaft, but free to slide on same. Thus the arrangement is capable of giving one double gear, one treble gear, three quadruple, and one quintuple gear. Thus:—Double, A, B, J, K; treble, A, B, C, D, E, F; first quadruple: A, B, C, G, H, I, J, K; second quadruple: A, B, L, M, G, C, D, E, F or A, B, L, M, G, C, J, K; third quadruple

A, B, L, M, H, I, J, K; quintuple, A, B, L, M, H, I, C, D, E, F.

Returning now for a moment to Figs. 53 and 54, we observe that by adding two more pairs of wheels which are placed upon either the second and third motion shafts, as in Fig. 62, or upon the second and first motion shafts, as in Fig. 63, we may obtain four quintuple gears in addition to the single gear, and four treble gears. Referring to Fig. 62, it will be seen that, instead of employing only three shafts, a fourth has been inserted. It is perfectly possible to carry out the arrangement as above described, but the design we have figured—62—is preferable, as the length of the headstock is not increased over that of Fig. 53, and the wheels O and N are always keyed in position, instead of being loose and sliding on the shaft.

The cone and wheels A, B, C, D, E, G, and K are arranged exactly as previously described for Fig. 53. On the third motion shaft, however, F, H, and M are keyed together upon a sleeve, which can be clutched to it or not as desired. An additional wheel P also is permanently keyed upon this shaft. The wheels N and O are situated between and behind the second and third motion shafts, and mounted upon a short fourth shaft mate with M and P. The drives then are:—Single gear, K, J; first treble, A, B, E, F, I, J; second treble, A, B, G, H, I, J; third treble, C, D, E, F, I, J; fourth treble, C, D, G, H, I, J; first quintuple, A, B, E, F, I, J,

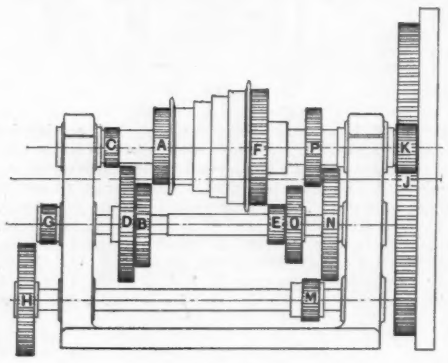


Fig. 63

M, N, O, P; second quintuple, A, B, G, H, I, J, M, N, O, P; third quintuple, C, D, E, F, I, J, M, N, O, P; fourth quintuple, C, D, G, H, I, J, M, N, O, P. The arrangement of Fig. 63 is similarly derived from Fig. 54, and the drives are:—Single gear, K, J; first treble, A, B, O, P, K, J; second treble, A, B, E, F, K, J; third treble, C, D, O, P, K, J; fourth treble, C, D, E, F, K, J; first quintuple, A, B, G, H, M, N, O, P, K, J; second quintuple, A, B, G, H, M, N, E, F, K, J; third quintuple C, D, G, H, M, N, O, P, K, J; fourth quintuple, C, D, G, H, M, N, E, F, K, J. As already remarked in connection with Figs. 53 and 54, we consider this arrangement in many ways inferior to that of Fig. 62.

In addition to the defects specified: the overhanging of G H without any corresponding shortening of the head, the great distance between H and M, and the provision of only one face-plate pinion; it is clearly bad practice to employ the gears O P and E F, which must of necessity have coarsely-pitched teeth to transmit the heavy drive of the quintuple gear, also for the light loads and high speeds of the treble drives. The corresponding gears of Fig. 62, viz., M N and O P, which are heavy and of large diameter, are only used for quintuple driving.

THE ORGANISATION OF A DRAWING-OFFICE.

By W. O. HORSNAILL, A.M.I. Mech.E., A.M.I.E.E.

No. II.*

Draughtsmen.—Having now described the drawing-office, furniture, and part of the system, it will be desirable to devote some space to considering the type of draughtsmen required to deal with the work. First, four or five first-class men, who will work out designs directly under the chief draughtsmen, will be wanted. These men will not be called upon either to finish up their drawings or to do any tracing. Secondly, eight or ten average draughtsmen capable of making shop drawings, lists of parts, ordering material, &c., will be needed. These men will be given a certain number of orders to deal with, and will be held responsible for the completeness and correctness of the shop instructions in connection therewith. The rest of the staff will be made up of junior draughtsmen and tracers, who will assist the senior men and work under their instructions. Two leading draughtsmen will be required to assist the chief, these men will each take charge of a section of the work, dividing between them the draughtsmen of the second class, together with a certain number of juniors and tracers.

Orders.—These will be of two kinds:—(1) Customers' orders; (2) stock orders. Each kind will have a separate consecutive set of numbers, and the original copies will be filed in Stolzenberg files in consecutive order.

Letters.—All letters reaching the drawing-office in connection with orders will be copied and filed in the order files above mentioned.

The system.—This will be best illustrated by tracing a customer's order for a large dynamo through the drawing-office. The original order, after having been checked by the estimate department, will be sent to the drawing-office, together with previous correspondence and specification, if any. The order should also be accompanied by a list showing the weights of materials and a reference to the drawing upon which the estimate was based, a list of these papers being marked upon the order. Two copies of the order will be made by the clerk, who will also stamp all the papers with the order number and the date and time of receipt. The original order will be filed, and all other papers will be handed to the chief draughtman, who will send one copy of the order to the electrical designer, with any papers bearing upon his portion of the work, the other copy being handed to one of the leading draughtsmen to be dealt with.

Nothing further can be done until the size of machine is confirmed by the electrical designer, who will give the electrical particulars to the drawing-office, and will prepare winding and testing instructions for the shops. In this connection it may be stated that all drawings affecting the winding, magnetic circuit, or ventilation, should be initialled by the electrical designer.

The size having been settled upon, the important parts of the designs will be worked out by one of the first-class draughtsmen above mentioned, his drawings being passed over to the leading draughtsman in charge of the order, who will hand it to one of his assistants to complete the drawings and order material. The latter operation should be tackled somewhat in the following order:—(1) Cast steel, (2) malleable iron, (3) commutator plates—if ordered abroad—(4) stampings, (5) cast iron, (6) heavy forgings, (7) brass castings. Wire will be ordered by the electrical department, but bars, commutator lugs, and butterfly end connections should be ordered by the draughtsman. The orders will be written out in triplicate, omitting the name of the supplier and the time of delivery, these items being filled in by the shop manager, who will receive two copies, the remaining copy being filed on the order file above mentioned.

Side by side with the ordering of material and the making of shop drawings, the draughtsman will make out a complete list of parts showing every item. This list should give the following particulars:—At the top will be given:—Order number, machine number, size, date of delivery, and penalty, if any; and in columns: (1) Reference number, (2) drawing number, (3) date of issue of ditto, (4) description, (5) pattern number, (6) material, (7) date ordered; (8), (9), (10), (11), blank columns. Four or five copies of these lists of parts will be issued to the shop manager for use in the various departments, who will fill in the blank columns as required.

One copy will be retained in the drawing-office, and filed in the order file.

Each detail drawing, tracing, or sketch, will be marked with the reference number and pattern number against every part. On general arrangement drawings of armatures, commutators, &c., the reference number and detail drawing number will be marked against each detail, surrounded by a small circle. On general arrangements of complete machines the reference and drawing numbers of the complete armature, commutator, &c., will be similarly indicated. These cross references may appear to introduce unnecessary complication; but, although more time is taking up in the drawing-office by their use, they will be found invaluable in saving time in the shops.

Whilst on this subject of drawings and tracing, it may be emphatically stated here that no alterations whatever should be allowed, unless every copy extant can be recalled and altered at the same time. That is to say, that no old drawing should be modified and used for a new machine, neither should the system of issuing a sketch showing the altered dimensions, with a note referring to another drawing for all other sizes, be permitted. This method is very attractive, and may save a little time in the drawing-office, but it invariably leads to mistakes sooner or later, which cost far more than the slight saving of time in the office; furthermore, time is wasted in the shops looking up extra drawings and picking out altered dimensions. If it be desired to use an old drawing with a slight alteration, two prints should be made, the alteration being marked on both, and a new tracing number taken, one copy being filed. If the alterations are considerable, it will be found cheaper to make a new drawing. Small sketches can be made on the lists of parts, but anything more elaborate should form the subject of a tracing. All prints, orders, lists of parts, &c., for the shop will be placed in a basket in the chief draughtsman's office for his signature, the dates having previously been entered on the office copies of the lists of parts. These papers, after having been signed and dated, are sent to the shop manager.

Effect of the system.—It will be seen that the list of parts is really the basis of the system described, as copies of it are used in all departments of the shops. These copies are most useful to the heads of departments, as by filling in the blank columns to indicate the progress of their part of the work, they can at any time quickly ascertain the position of each order. Moreover it is possible for the works manager to have a master copy of each list of parts kept up to date for his own periodical inspection. The making of these complete lists no doubt takes up extra time in the drawing-office, but the advantages are so great from a shop's point of view that the additional office cost is amply justified.

It will be noted that the orders are passed on to individual draughtsmen, who are each held responsible for the shop instructions in connection with the orders commited to their charge. This system is found to work exceedingly well, the draughtsmen being much more contented and interested in their work than is the case where each man specialises in some particular part, such as commutators, magnets, &c., although under the system above described each draughtsmen should be confined to certain sizes and types of machine. Also the question of overtime is more easily dealt with, so much so that with very little encouragement the men will put in extra time on urgent orders for which they are responsible on their own initiative. Another important feature of the system is the ease with which orders can be referred to, all the papers being contained on one file. It is strongly recommended that files of the Stolzenberg type be used for this purpose, as the papers are tightly pressed together, and less likely to be torn out than with the ordinary spring letter file.

Drawing materials.—This article would not be complete without a word or two on the subject of materials for drawing-office use. All materials should be kept under lock and key by the clerk, excepting one roll each of drawing paper, tracing paper, and tracing linen, from which draughtsmen will cut off lengths as required. For a similar purpose one roll each of printing paper and cloth and white printing paper will be issued to the photographer, who will apply to the clerk when fresh rolls are required. Pencils, rubber, drawing pins, and similar small articles will be issued by the clerk, who should enter such supplies under each draughtsman's name in a book kept for this purpose, which will be periodically inspected by the chief draughtsman. This method has the effect of making the staff much more careful with their material than would otherwise be the case, and considerable economy will result from its adoption.

The clerk should also keep a ledger, in which a separate account for each different kind of material will be entered. On one side will appear the items as received from the suppliers, with the price marked against each consignment, the other side being posted up from the draughtsmen's material book mentioned above; each account should therefore balance as regards quantities. Recent prices are given below of materials which form the largest items in the drawing-office expenses account. The cost of such material has been much reduced in the last few years, and a similar reduction will no doubt continue, so that the figures will not hold good for long. Blue printing paper, a good quality, can be bought for 1s. per roll in two-dozen roll lots. Blue printing cloth can be obtained for 5s. 9d. per roll in two-dozen lots. Drawing paper—continuous paper 30in. wide at 4s. per roll will be found good enough for general purposes. Tracing paper—a tough, glazed paper is the best, and 4s. per roll in one-dozen roll lots is enough to give for it. Tracing linen—slightly damaged rolls can be obtained in two-dozen roll lots at 9s. per roll. White printing paper—if nicely finished prints are required for tendering purposes, a good quality of paper must be used, which can be obtained for about 4s. per roll in six-roll lots.

In conclusion.—It is not intended in the above article to give every little detail of the system described, as such require modification to suit various classes of work; but the main lines are given along which drawing-offices, dealing with a variety of work can be run. It may also be mentioned that a large drawing-office has been conducted on this system under the author's supervision for several years, and has amply proved the success of the methods herein advocated.

* No. I. appeared December 1st.

THE CONSTRUCTION OF A GREAT LINER.

THROUGH the courtesy of the builders—Swan, Hunter, and Wigham Richardson, Limited, of Wallsend-on-Tyne—we are enabled this week to give half-a-dozen reproductions of photographs of the express passenger steamship they are building to the order of the Cunard Company, a similar vessel, as is well known, being under construction in the yard of John Brown and Co., Limited, Clydebank. The pictures illustrate in a striking way a great ocean steamship "in the making," and in the earlier stages. They also give a fair idea of what the facilities are in an up-to-date modern shipyard provided with overhead electric crane equipment for dealing with the erection and conveyance of material, and with the transporting, and holding to their work, of hydraulic and other appliances for drilling and riveting material of the heaviest scantling now worked into merchant ship structures. The covered-in shipbuilding berth on which the great Cunarder is being built at Wallsend is 740ft. long—but can at any time be extended to 900ft.—with a clear inside width of 100ft. and a height of 144ft. All the covered-in berths are equipped, as is seen on some of the engravings, with numerous electric overhead cranes.

To the experienced shipbuilder or marine engineer the views presented will convey perhaps an adequate impression of these things, and in their case any apology for the paucity in detail of the present description of this very notable shipbuilding work is not so necessary. Beyond adding a few general comments, drawing attention to the most noticeable features exhibited by the several engravings, it is not possible for us at this time to go; but before entering upon this, a few authentic particulars may be given of what these Cunarders, as completed productions, will be, or are intended to be. Four of the engravings referred to are printed in a separate supplement, which accompanies this issue, whilst the other two will be found on page 568.

The leading dimensions of the vessels are:—Length, 785ft. over all; between perpendiculars, 760ft.; beam, 88ft.; and depth moulded, 60ft. 6in. They will have accommodation for over 500 first-class, 500 second-class, and about 1200 third-class passengers. Accommodation will also be provided for a crew of about 800. With a "full complement," therefore, each of these great vessels will have a population of 3000 souls on board. The propelling machinery, which is on the Parsons Marine Steam Turbine Company's principle, is being constructed by the Wallsend Slipway and Engineering Company, Limited, at Wallsend. There will be four turbines driving four shafts, each having one propeller, and the vessels and machinery are being constructed under agreement with the Government to attain a sea speed of not less than 24½ knots. In ordinary Atlantic weather this will enable the vessels to traverse the distance of about 2900 knots from Daunts Rock Lightship, Queenstown, to Sandy Hook, New York, in five days. Should they even fall something short of this performance, these Atlantic express steamers will

undoubtedly represent the highest attainment in naval architecture and marine engineering.

Our illustrations, reproduced from photographs taken at irregular intervals, may now be briefly referred to. Fig. 1 shows the mid-ship portion of the cellular double bottom of the vessel. The whole of this part of the structure, including the bottom shell plating, is riveted by hydraulic pressure, and from this view, as well as several of the others, a good idea may be gathered of the method of carrying out the work, and the heavy tools employed in doing it. The floors with bars attached, having been riveted together, are brought into position by means of the five electric overhead cranes with which the covered-in berth is equipped—as seen most clearly in Fig. 5, page 568—and are riveted to the centre keelson by means of large-gap hydraulic riveters, these having gaps up to 6ft. These machines, as also seen in Fig. 5, are carried by light swinging jib cranes fastened to the columns of the covered-in berth. These swinging cranes are portable, and can be easily transported by the electric overhead cranes and fixed anywhere required. The overhead cranes are, of course, much in demand for transporting and erecting the heavier items in the structure. Fig. 1 in our series, taken in the latter end of November last year, is followed by Fig. 2, taken about the middle of February this year, which, besides showing the double bottom, also shows the side framing erected. Taken from the fore end this view also shows portions of the stem bar in position. Fig. 3, taken at the beginning of April, is a view from the aft end, showing the forward portion of the framing erected, and the inner bottom partly plated. The double bottom, as will be seen, extends well up the round of the bilge for the sake of increased strength and increased safety. As may also be seen, from this and other views, the framing consists of channel bars and deep web frames closely spaced. This feature is even better brought out in Fig. 4, which also illustrates clearly the mode of suspending the hydraulic riveting tools already referred to. The framing in this view, as will be seen, has been completed to the stem, and the transverse and longitudinal bulkheads are erected to level of lower deck. Fig. 5, which has been already referred to as affording a good idea of the overhead electric, and the side swinging jib cranes, is taken, as will be obvious, from the aft end, and clearly shows the channel frames and web frames, also the deck beams in position as far as the machinery bulkhead. A peculiarity of almost all the illustrations is that the great height of the covered-in berth standards, and the runners with electric overhead cranes, somewhat dwarf the height of this great vessel itself.

The illustration, Fig. 6, the last of our present series, shows a vitally important part of the huge liner, and at a highly interesting stage of the work of construction. This is a view from aft, and exhibits the frames as they approach the stern post, and the bossing necessary for the outside propeller shafts, also the sweep up of the "deadwood" to meet the fore end of the stern-post casting. In connection with this view readers may be referred to the illustrations of the steel stern frame casting and propeller brackets for these vessels given in THE ENGINEER for September 29th last. By means of these he will be able in his mind's eye to construct the stern end of the turbine liner, and estimate approximately the position of the four lines of shafting relatively to each other. The items there clearly illustrated as erected in the works of the makers, the Darlington Forge Company, are those for the Clydebank vessel, but the Wallsend vessel's castings, also made at Darlington, are almost identical. These are by far the largest castings of the kind ever worked into a ship structure. The stern-frame alone weighs, as finished, 47 tons. Each of the pair of aft brackets weighs 22¼ tons, while each of the forward brackets has a weight of 24 tons. The total weight of the rudder when fitted will amount to 70 tons, the diameter of the stock being 26in. The height from the bottom of the rudder blade to the top of the stern is 55ft. Altogether the aggregate weight of rudder, stern-frame, and brackets will closely approximate to 220 tons. These items alone illustrate the leviathan character of these new Cunarders.

NEWEST CALEDONIAN ENGINES AND THEIR WORK.

By CHARLES ROUS-MARTEN.

RECENTLY I set forth in some detail the gradual development of the means employed by the locomotive department of the London and North-Western Railway for overcoming the difficulty of a very severe though short incline standing right in the middle of a long non-stopping and fast-timed run. It will be remembered that these various devices have culminated in the adoption of a six-coupled bogie locomotive of great power, which in very unfavourable weather and rail condition gained four minutes with a train of 320 tons in the fastest-booked run and attained a speed of 27·7 miles an hour up the Shap Incline of 1 in 75, from a dead start on the bank. It will be interesting to see what is being done simultaneously by the London and North-Western's ally in the Anglo-Scottish West-Coast service, the Caledonian, which works that service, and the same trains from Carlisle to Edinburgh, Glasgow, and Aberdeen respectively.

The famous "race to Aberdeen" of ten years back, and its anticipated resumption in 1896, may be said to have originated the genesis of the new era in Caledonian locomotive practice. Some of the experiences of that "race" and its associations had indicated the need of more powerful engines, particularly in respect of boiler capacity, in order that the Beattock incline with 10 miles continuous ascent at 1 in 88 for two miles, 1 in 80 for a like distance, and finally 1 in 75 for six miles on end, might become a less formidable obstruction to acceleration of inclusive speeds than it had proved during the "race." The outcome was the production by Mr. J. F. M'Intosh—who had very shortly before assumed the locomotive chieftaincy which he still so ably holds—of his justly-celebrated "Dunalastair" type of express engine. These engines were described by me at the time of their advent in 1896 and illustrated in THE ENGINEER of that year. It will be remembered that they were given boilers 4ft. 8in. in diameter, with 1400 square feet of heating surface, inside cylinders 18½in. by 26in., and 6ft. 6in. driving wheels four-coupled. It will also be remembered that these fine locomotives performed some of the smartest work ever seen in this kingdom up to that time, their performances, indeed, having much to do with bringing about the high-water mark in respect of booked speeds which Britain attained in that year. The "Dunalastair" type has remained the standard design upon the Caledonian Railway ever since, although the successive batches of engines built according to that plan have undergone steady development in respect of dimensions and a few minor modifications in details.

The second batch that came out have usually been known as the "Breadalbane" class, one of their number being given that name on a particular occasion. The original "Dunalastairs" were numbered 721-736; the "Breadalbanes" bore the numbers 766-780, there being fifteen in each batch. The later ones received slightly larger boilers, with 1500 square feet of heating surface, cylinders 19in. in diameter, and 175 lb. steam pressure. They, too, have done excellent work, only superior to that of the "Dunalastairs" to the extent of their enhanced nominal power. A number of the 6ft. 6in. coupled engines previously built by Mr. D. Drummond for the Caledonian line have since been converted by Mr. M'Intosh into this type, with very useful results. Next came the third variant of the "Dunalastairs," known as the "900 class," their list running from 887 to 902 inclusive. These, in their turn, had augmented heating surface, 1600 square feet, and an increase of boiler pressure to 180 lb. per square inch. They have done a large amount of exceptionally fine work, some of their exploits in hill-climbing with heavy loads at high speeds being among the best of which there is any authentic record. Lastly have come the class now under notice, known as the "140" set, of which Nos. 140-144 have been running for some little time; while Nos. 145-150 are at present in course of construction at the St. Rollox works. But although the engines of the "140" class, like each set of their predecessors, exhibit a continuous course of development and improvement, the type remains the same as that which made its first appearance nearly ten years ago, the "Dunalastair" design, although No. 140 and her sister engines in their turn possess certain minor but specific improvements. It will be observed that in this immediate connection I do not refer to the two mammoths, No. 49 and 50 of the 4-6-0 order, which Mr. M'Intosh brought out two or three years ago, and which I duly described and illustrated in these columns, also giving specimens of their very admirable work. These and their smaller, but still huge, sister engines, Nos. 55-59, belong to quite a separate order, and must be dealt with separately. For the present I confine myself to observations of the "140" class.

A casual glance at No. 140 reveals little if any perceptible difference in outside aspect from No. 900 or No. 780, and but little from the original "Dunalastairs." The same general features of design and appearance are maintained in all four classes. No. 140 has apparently a very similar boiler to that of No. 900, merely a little larger in girth, while her total heating surface shows a very small increase, the total being 1615 square feet. But it should be added that this amount, which may seem small as compared with the 2400 square feet of No. 49, is, nevertheless, so judiciously disposed—this being all the more feasible through the general design following the more ordinary plan of the 4-4-0 arrangement, and thus escaping the difficulties which attended the 4-6-0 method with the leading coupled wheels as the drivers—that it is, in reality, equal in efficiency to a much larger amount less skilfully placed. And certainly it has proved in practice sufficient to enable these engines to perform work which falls very little short of that accomplished by the more gigantic 4-6-0 set. There is, however, one very material difference between the boilers of No. 140, &c., and those of No. 900, &c., although this is not perceptible externally. In outward aspect the boilers of these newer engines are perfect cylinders, without any sign of coning or taper; in reality, however, they are of the wagon-top order, like those introduced on the Great Western Railway by Mr. Churchward, that is to say, expanding outwardly toward the fire-box, so that the diameter at the point where the fire-box is met is slightly in excess of that at the smoke-box end or midway in the boiler length. I may remark in passing that it seems to me desirable that some definite designation should be adopted with regard to these boilers, which are tolerably certain to become much more common in British locomotive practice in the future than they have been in the past. If the American term "wagon-top"—or "extended wagon-top" if the expansion extend practically all the way from smoke-box to fire-box—be objected to, it would seem well that some specific name less ambiguous than "taper" or "cone" as applied to this form of construction should be agreed upon. For although it may be true that the boiler does taper inward to a certain extent from the fire-box, yet, as its novel feature consists in its not tapering, but expanding, outwardly from the front, instead of remaining of the same girth all the way, the term "taper" might be thought to convey a somewhat inaccurate idea regarded from a strictly scientific standpoint. "Coning" might in some respects be better, at any rate in analogy with the use of the term in railway practice as applied to the construction of wheels. But as the result in either case is not a true or complete cone, but only the frustum of one, this expression, too, seems to lack some of the desirable precision.

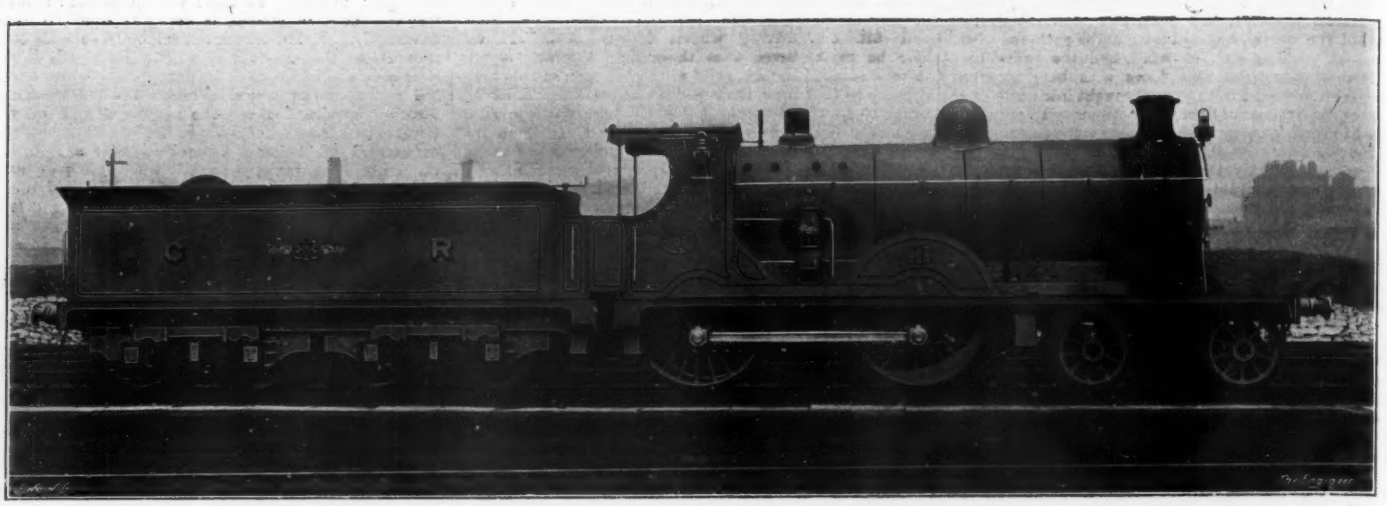
I have said that the new boilers present no external difference, except in point of size, as compared with the former ones. Those on the Great Western exhibit, it will be remembered, a very marked difference, which is, perhaps, not altogether symmetrical or pleasing to the eye, although one soon gets used to the change. Mr. Churchward, however, takes the purely non-æsthetic view, "Handsome is that handsome does." Indeed, he himself remarked to me, "People may say that these boilers are ugly; but they do their work, and that is what I want." This, of course, is perfectly sound reasoning; nevertheless, Mr. M'Intosh felt reluctant that his engines should lose the external symmetry for which they had long been admired, and so he determined, while adopting the new shape of boiler, to retain the old symmetrical form by carrying forward the lagging and sheeting in a straight line from smoke-box to fire-box, thus leaving the exterior of the boiler a perfect cylinder as before. In other words, he pursued exactly the same plan as that which Sir Christopher Wren adopted in designing the dome of St. Paul's Cathedral. Everybody who knows anything about the subject is aware that the superb dome, which is seen and admired externally, is not the true cupola of the cathedral, which in reality is a smaller and more matter-of-fact, also a greatly less beautiful structure, concealed by the graceful curves of the external casing. So it is with the Caledonian "140's." They have the new boilers expanding toward the fire-box, and thus giving increased steam area in the part where it is most useful; but externally they have the same symmetry of outline as their forbears. And it is not perceptible that anything of practical efficiency is sacrificed by the employment of this harmless device for retaining it. For the rest, these engines have, like their predecessors, inside cylinders, 19in. by 26in., 180 lb. steam pressure per square inch, and 6ft. 6in. four-coupled wheels. They can therefore exercise a nominal tractive force of 120 lb. for every pound of effective pressure in the cylinders. Only five of the class are as yet in regular work, Nos. 140 and 141, working the best express each way between Carlisle and Edinburgh, Nos. 142 and 143 performing the same duty between Carlisle and Glasgow, while No. 144 works between Perth and Aberdeen.

Recently, through the courtesy of Mr. G. Calthrop, general superintendent, and of Mr. J. F. M'Intosh, locomotive superintendent of the Caledonian Railway, I had several opportunities of carefully observing and noting the way in which the engines of the "140" class performed the work set out for them. This is certainly of no trivial nature. In point of fact, it has no equal in Britain in point of extreme arduousness, when the loads, gradients and speeds are taken into joint account. In the first place, the fastest Carlisle—Edinburgh and Carlisle—Glasgow expresses quite commonly exceed 380 tons and often 400 tons in weight behind the tender, that is to say, exclusive of the weight of engine and tender. Secondly, the gradients are extremely severe. On the down journey there is a rise of more than 1000ft. from Carlisle to the Beattock summit. Even from Carlisle to Beattock Station, at the foot of the Beattock incline, the road is by no means easy. That distance of 39¾ miles includes continuous lengths at 1 in 200, or steeper for eight miles, four miles, and five respectively, the grades in the latter case finally steepening to 1 in 165 before the incline proper is started, after which come two miles at 1 in 88, two at 1 in 80, and the six miles unbrokenly at 1 in 75. Even then there are three miles more of 1 in 200 up before Strawfrank Junction—just south of Carstairs—the point of bifurcation, is reached. And on diverging to the Edinburgh line the engine has to face 9 more miles of virtually continuous ascent, much at 1 in 100, to the Cobbinshaw summit, whence there is a steep drop for 18½ miles into Edinburgh. This, coming from Edinburgh southward becomes, of course, a severe ascent, almost all steeper than 1 in 150, four miles being at 1 in 142, two at 1 in 132, two at 1 in 120, and, lastly, six consecutive miles at 1 in 100 to Cobbinshaw summit. Then, after joining the main line at Strawfrank, there is a nearly continuous climb of 23¼ miles to Beattock summit, chiefly at 1 in 200 to 1 in 300, but at 1 in 100 for the last two miles on end. Strictly speaking, the ascent is broken by three minor descents near Thankerton, Lamington, and Elvanfoot respectively, but, nevertheless, remains a very hard pull for a heavy train at high booked speed. Thirdly, that same booked speed, on the up journey at all events, is certainly high for such loads on such a road, viz., 50·4 miles an hour from start to stop. The corresponding down journey has—in the public time books—25 minutes more allowed than was the case from the conclusion of the "Race" in 1888 up to a comparatively recent date, viz., 2 h. 25 min. instead of 2 hours, but in the working time-book, the allowance is 12 minutes less than this, viz., 2 h. 13 min. for the 100¾ miles.

Making an experimental journey with the 10.5 a.m. West Coast London express from Edinburgh to Carlisle, I found No. 140 heading an enormous train, extending from the buffer stops at Prince's-street Station to a van's length outside of the platform end. According to the weights of rolling-stock officially supplied to me, and after counting the passengers and staff, and estimating as closely as possible the weight of luggage and stores, the total load behind the tender of No. 140 was 404 tons. I may remark in passing that this would have been reckoned as "forty coaches" on the South of England lines, or, indeed, on any British line a quarter of a century ago. No. 140 had a very smart driver, Stavert, of whose fine achievements with engines of the "900" class I have previously written in these columns. But even he was not prepared to risk, unassisted, that 18½ mile climb to Cobbinshaw, much at 1 in 100, hauling a load of 404 tons. As subsequent events demonstrated, he and No. 140 could unquestionably have got up the steep bank all right, and at a fair speed; assuredly there was never any risk of "stalling," and later a grade identical with the worst of that to Cobbinshaw was ascended at a minimum rate of 36 miles an hour. But it is rightly deemed most important that this train should be delivered at Carlisle infallibly to time, and so

FOUR-COUPLED EXPRESS LOCOMOTIVE, CALEDONIAN RAILWAY

MR. J. F. M'INTOSH, ST. ROLLOX, GLASGOW, ENGINEER



it was not thought wise to risk any delay, even slight, by slipping or otherwise on the Cobbinshaw climb. Accordingly, the aid of a pilot engine for that length was requisitioned, one of Mr. Connor's small 7ft. coupled outside-cylindered class, No. 33, rebuilt by Mr. M'Intosh, being put on. The power of the pilot was so small as compared with that of the train engine that the principle of assistance, instead of a sharing of the load—as when two locomotives of approximately equal power are employed—was strongly emphasised. Under these conditions the severe climb of 18¼ miles to Cobbinshaw summit became relatively easy, and that point was reached in 28 min. 57 sec. from the Edinburgh start. Here No. 33 went off, leaving No. 140 to haul unaided that load of 404 tons for the remaining 82¼ miles. This distance, including all the rising grades already mentioned, was covered in the excellent time of 87 min. 21 sec. from start to stop, averaging 56·6 miles an hour with that enormous load. I have seldom at any time recorded a performance so fine as this, and I cannot remember that I have ever known of a better one, taking all the circumstances into consideration. After slowing through Strawfrank Junction, the speed steadily increased up the subsequent two miles, rising at 1 in 150, until a rate of 42·9 miles an hour was reached, the same point being attained up the short length at 1 in 100 approaching Symington. South of that station, and before Lamington, comes one of the short "breathing places," two miles of easy descent, where our speed soon rose to 60 miles an hour. Up the 10 miles of unbroken ascent, chiefly at 1 in 150, 1 in 200, and 1 in 300 between Lamington and Elvanfoot, the speed never fell below 43 miles an hour, and the average was 46·5. But the final two miles of 1 in 100 to the Beattock summit constituted the real crux of the whole journey. Here the speed at first dropped steadily, as was certain to be the case with so vast a load on such a grade. In the end it fell to exactly 36 miles an hour, but at this point it kept steadily, quarter-mile after quarter-mile, until the summit was reached, each quarter-mile being covered in exactly 25 seconds, as tested by two chronographs, whose respective starting and stopping buttons were pressed simultaneously as each quarter-mile post was passed. The engine never showed the least sign of flagging or slipping, and was "going strong" as ever when the summit was breasted. This performance equals anything I have recorded, even with Mr. M'Intosh's six-coupled giants, Nos. 49 and 50, but it must, of course, be remembered that No. 140 had fine, calm weather, and a dry rail. In drizzly or snowy weather, with side wind and slippery rail, the additional adhesion possessed by the six-coupled engines would of necessity tell. But for any four-coupled locomotive to maintain a minimum rate of 36 miles an hour up a continuous grade of 1 in 100 hauling 404 tons behind her tender is a feat whose merit needs no demonstration. The Beattock incline was descended at a cautiously restrained speed, but after its foot was passed at Beattock Station Stavert let his engine go once more. Wamphray—5½ miles—was passed in 4 min. 35 sec., at 76·3 miles an hour; Dinwoodie—2¾ miles uphill and half down—in 2 min. 29 sec. thence; Nethercleugh, 3 miles—half down and half up—in 2 min. 40 sec. The train now had got on the 7 miles rise at 1 in 200 to 1 in 528 that extends southward past Lockerbie, and here the speed, of course, fell off, but only to 57 up the 1 in 528 and to 50 up the final bit at 1 in 200. Down the long fall that succeeds, the speed rose to a high point, reaching 80·3 miles an hour between Kirkpatrick and Gretna, where the gradient is 1 in 200 down, and being still maintained at over 70 when Rockcliffe was passed, after 3 miles rise at 1 in 528.

In the end Carlisle was reached in 117 min. 50 sec. inclusive from Edinburgh, or 2 min. 10 sec. under booked time. But this included a dead stand for 1 min. 38 sec. at Cobbinshaw, dropping the pilot, which leaves 115 min. 12 sec. as the actual travelling time, and 112½ min. as the net time for the 100¾ miles. Such work as this speaks for itself. I may remark, however, as a curious corroboration of the view I expressed at the outset that No. 140 could have kept time without having the aid of a pilot to Cobbinshaw had this been attempted, that as a matter of fact No. 140 attained and sustained up the rise at 1 in 100 approaching Beattock summit from the north, the same speed as she did with pilot assistance up the same grade approaching Cobbinshaw, each of these grades, moreover, being preceded by a long continuous ascent.

With a less, but still considerable load, of 260 tons behind the tender, No. 144 of the same class, driven by Mitchell, made a very smart journey from Aberdeen to Perth, the train being the Grampian Express, composed of the exceedingly fine and luxurious new twelve-wheeled coaches designed and built by Mr. M'Intosh at St. Rollox. The climax consisted in the fastest-but-one booked run east of the Atlantic having to be done with that load, viz., Forfar to Perth, 32½ miles, in 32 minutes, averaging 60·9 miles an hour from start to stop. For some unexplained reason the Caledonian chooses to "hide its light under a bushel," and does not show this remarkable timing save in its working book. However, No. 144, smartly driven by Mitchell, did the run with ease in 31 min. 1 sec., attaining a maximum of 83·4 miles an hour down a moderately falling gradient.

One more experience with these locomotives deserves mention on account of its smartness, although in this case the load was light—170 tons, which would be reckoned as "seventeen coaches" on some British lines. The train was the 10 a.m. from Euston, which was taken from Carlisle by No. 141, driven by Watt. Owing to a late arrival at Carlisle from the south, the departure was a good deal behind time. This, however, was all in our favour, as it enabled Watt to "let out" his engine, and the outcome was very interesting. Getting away from Carlisle, No. 141 seemed almost to leap into speed, so that she was going at 60 miles an hour before the third mile was completed, and covered the first four miles in 4 min. 48 sec. At the seventh milepost we were doing 75 miles an hour, and the long rise for nearly 15 miles at 1 in 200 with only a short midway break did not bring the speed below 60. Down the slight descent after Lockerbie we attained 77·5 miles an hour, the maximum rate of the whole run. Lockerbie—25¾ miles—was passed in 24 min. 55 sec. from the start, and Beattock—39¾ miles—in 37 min. 19 sec.—a reminder of the days of the earliest "Dunalastair" in 1896. We should assuredly have completed the first 50 miles out of Carlisle, including the ascent of the Beattock Bank, in the even 50 minutes, but at the Auchincastle box, about 1¼ mile from Beattock, we encountered adverse signals, and were stopped dead for 2 min. 43 sec. A fresh start had therefore to be made on the steep bank; nevertheless, the speed rapidly rose to 36 miles an hour, which was sustained for several miles on the 1 in 75 up; and after being for one-quarter mile brought down to 33 by a drizzling mist and slippery rail near Greskine, this rate—36 miles an hour—was recovered, and then sustained unwaveringly to the summit. The 23½ miles of falling grades to Strawfrank occupied 21 min. 19 sec.—two minutes longer than the time in which I have more than once done it, which shows how moderate was the running without any attempt at extra speed. Strawfrank—73½ miles—was passed at reduced speed in 75 min. 35 sec. travelling time from Carlisle, and the final 27½ miles into Edinburgh occupied 32 min. 4 sec., which, again, is 4½ minutes longer than I have taken on one or two occasions over that distance; but Watt carefully eased down in descending the Cobbinshaw bank, and made a most cautious approach to Edinburgh. Nevertheless, we stopped in Princes-street Station in just 110 min. 12 sec. from Carlisle, the actual travelling time being only 107 min. 29 sec. This may go to show how much time the Caledonian has in hand under the present booking, for the allowance in the passenger time-table is as much as 145 minutes, though in the working book the allowance is 134 minutes. But Watt and No. 141 did it in 107½ minutes running, or 104½ minutes net, although the engine ran largely within her powers down all the falling grades.

The "140's" were not running the Carlisle—Glasgow trains at this particular time, and so I had no opportunity of testing them on that service, but the performances which I have recorded above sufficiently show that they can accomplish with ease any work yet required on the Caledonian Railway.

AMERICAN THRESHING MACHINES AND TRACTION ENGINES.

No. V.*

In the threshing machines built by the Case Company, of Racine, all except the small sizes have 20-bar cylinders, and the regular machines are made in five sizes with cylinders 28in., 32in., 36in., 40in., and 44in. diameter. The general size, shown in Fig. 22, has the 32in. cylinder, which revolves at 750 revolutions a minute, and is mounted on a 2½in. shaft with 13½in. driving pulley. Each of the 20 bars is fitted with nine teeth, made of steel, containing

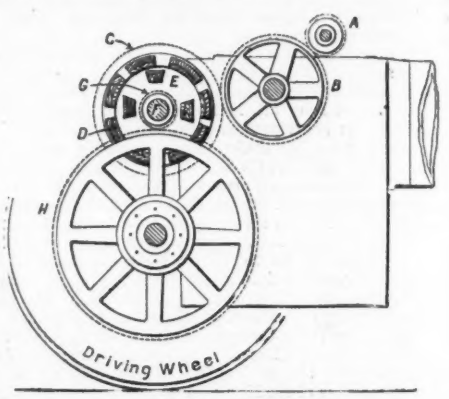


Fig. 20—CASE DRIVING GEAR

0·35 to 0·50 per cent. of carbon, and about 0·55 per cent. of manganese. The concave frame carrying the fixed teeth is of cast iron; the grate which forms an extension of the concave is of wrought iron, and so designed as to allow the large proportion of grain separated at this point to pass freely to the conveyor which delivers it to the sieves. Behind the cylinder and over the end of the grate is another revolving cylinder, the beater, having four curved blades or wings of sheet steel. This spreads the straw, and delivers it to the straw rack which has an oscillating motion, carrying the straw through the machine and shaking it so as to separate the grain. The grain from the concave, grate, and rack, falls into a rocking or vibrating conveyor, consisting of an oscillating

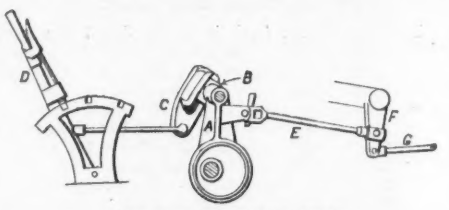


Fig. 21—CASE VALVE GEAR

trough connected to the same levers as the rack, both being operated by rods from a crank shaft running at 230 revolutions.

At the end of the conveyor is a shaking sieve, and beneath this another sieve operated by a rod from the fan shaft. In passing through these sieves the grain is subjected to a blast from a fan, the clean grain falling through to one screw conveyor, while the lighter dust and the tailings from the end of the sieve fall into another conveyor, and are delivered to an elevating conveyor having a continuous chain fitted with flights. This conveyor is driven direct from the crank shaft, and has its upper shaft carried in sliding boxes, so that it can be adjusted to take up any slack or stretch in the chain. This upper shaft also carries a small sprocket chain driving a screw conveyor discharging the tailings at the

* No. IV. appeared December 1st.

front of the machine. The fan has four blades, and extends the full width of the machine; it is driven from the cylinder shaft by a 4in. belt running over the belt which drives the beater and crank shaft. The force of the blast is regulated by upper and lower blinds. The straw falls into a hopper at the end of the machine, from which it is carried to the stack by a stacker rake having slats on a rubber belt, or by a wind stacker through which the straw is blown by a centrifugal steel fan

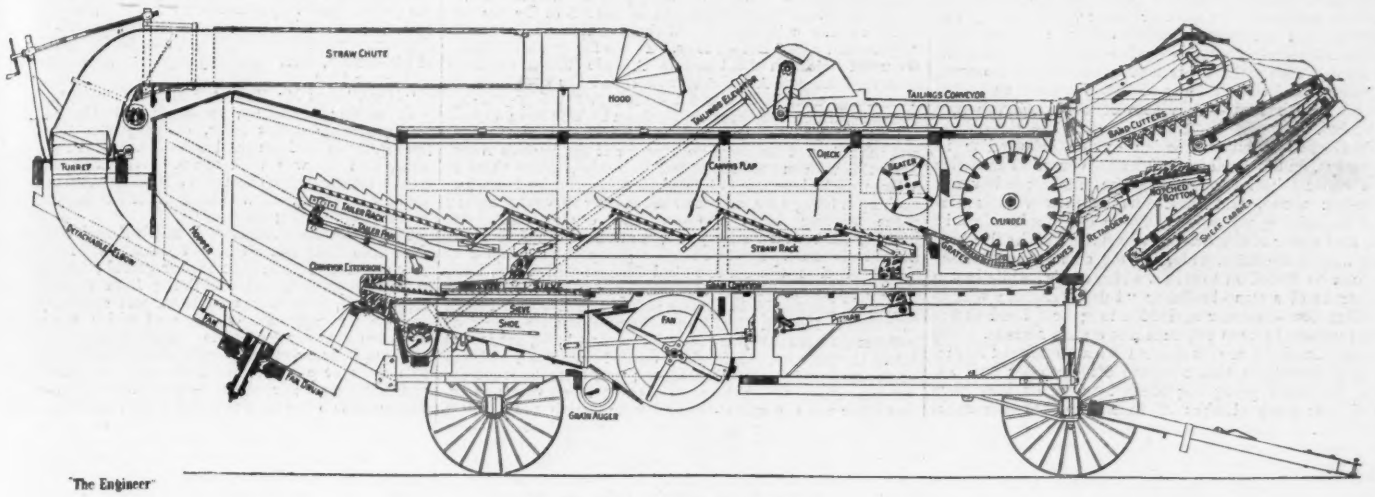


Fig. 22—CASE THRASHING MACHINE

running in ball bearings, and driven at about 650 to 750 revolutions. The operator can raise or lower the stacker, shorten or lengthen it, swing it around, and manipulate the hood from his platform, so as to regulate the building of the stack. The fan is driven from the cylinder shaft, having a bevel gear connection to the fan spindle. The stacker and the sheaf carrier or feeder fold up when the machine is not in use or is on the road.

Most of the machines are self-feeders. A travelling rake-carrier, which runs at 61ft. to 103ft. per minute in

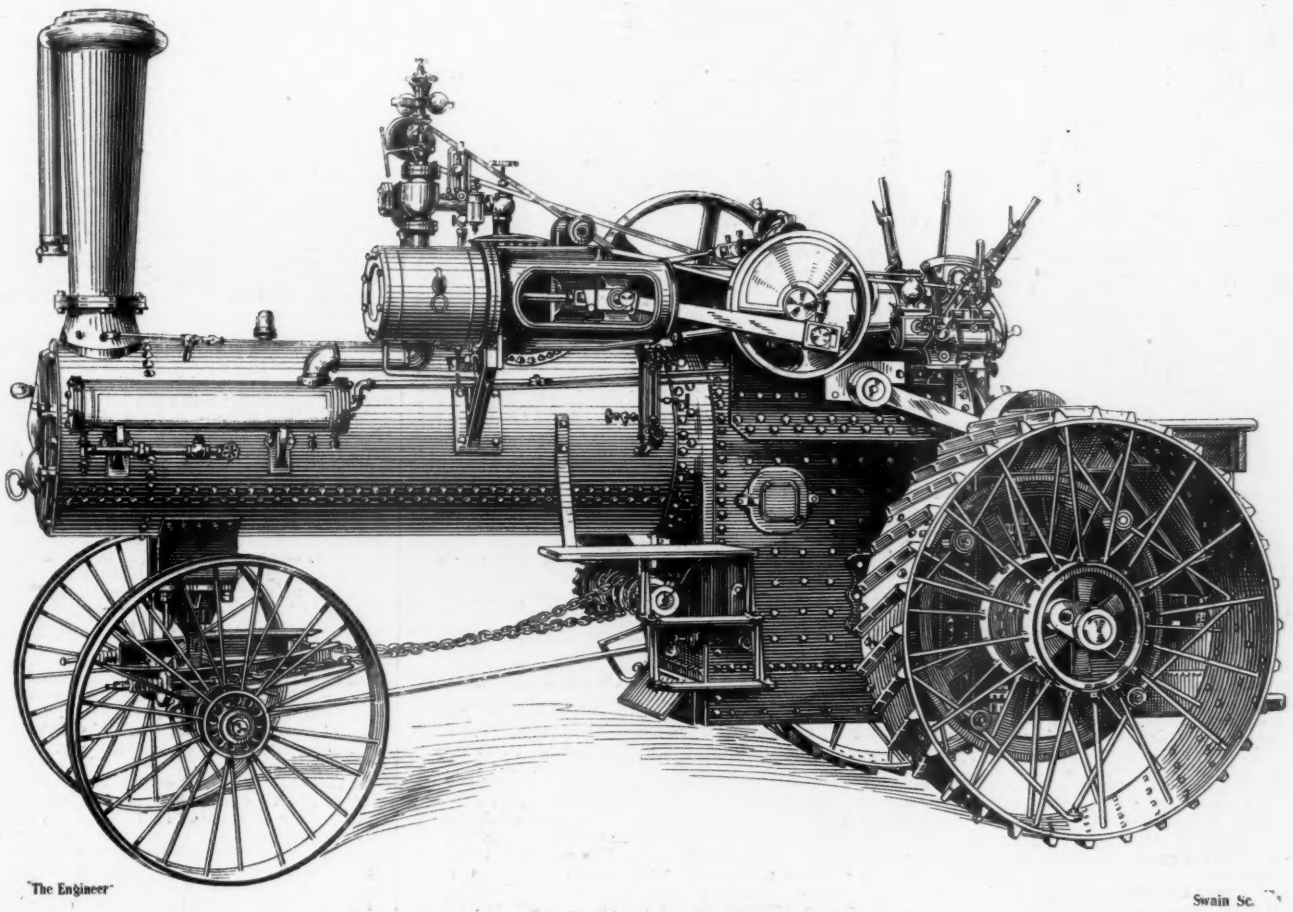


Fig. 23—CASE TRACTION ENGINE

different machines, delivers the bundles lengthwise to a feeder having curved revolving arms, which momentarily holds in check the bundle, while the oscillating cutter bars make a stroke and sever the bands. The feeding mechanism is controlled by a governor on the main driving pulley, consisting of weighted levers attached to springs, and carrying steel friction bands. As the wheel revolves and attains full speed, the weights are thrown outward until they pull the bands into contact with the face of the inner pulley to which the feeder crank shaft is attached, and thus drive the shaft. When the speed is reduced the spring pulls the weighted arms inward, and the friction bands fall clear of the pulley, when the feeder is at once stopped.

The grain conveyor delivers the grain to a vertical conveyor discharging into a weighing hopper, and when this is full it discharges through spouts into a wagon or into bags. In the latter case a counter or tally is used, which automatically records the number of bags loaded.

These machines can be adapted to threshing peas and beans, and to hulling clover, by the use of special con-

caves having teeth of special design set close together. A re-cleaner is also used in this case.

The type of traction engine built by the Case Company, Fig. 23, has a locomotive boiler, with the inside fire-box sheets bent and flanged to be riveted to the outside sheets at the bottom and at the fire-door, except that a reinforcing ring is laced between the sheets at the fire-door. In one side is a door for removing ashes that accumulate on top of the brick arch used in straw-burning boilers. In the cast iron chimney is a deep inverted coil of wire netting, and the narrow annular space between the top of the chimney and the coil opens into a hollow moulding with a vertical drop pipe to discharge cinders. A feed-water heater is used.

The driving wheels are carried by a long axle behind the fire-box, and both of these wheels are driven, the countershaft having gears at each end, which is not the usual practice in traction engines. The driving gear is arranged as follows—Fig. 20:—The pinion A on the engine shaft meshes with an idler spur wheel B, meshing in turn with the spur wheel C of the differential gear, which enables one driving wheel to move independently of the other in turning curves. The centre of this wheel is separate from the rim, and spiral springs D are fitted between lugs on the centre and rim to absorb shocks in starting and to give an elastic or cushioned transmission. In the wheel centre are four bevel pinions E on radial shafts, and these gear with a bevel wheel on the countershaft; this shaft F has pinions G at the ends gearing with spur wheels H bolted to the spokes of the driving wheels. The differential gear normally revolves as one wheel, but in rounding curves the bevel pinions run forward or back on the bevel spur wheel of the countershaft. The gear is made of cast iron strengthened by the addition of steel scrap in the cupola.

The cylinder is carried by a bracket riveted to the boiler, and drives back to a crank disc whose shaft is mounted in plates riveted to the sides of the fire-box. A D-slide valve is used at the side of the cylinder, and is worked by a single-excentric valve gear—Fig. 21. The short excentric rod or arm A—formed in one piece with the strap—is vertical, and connected to a block B sliding in a curved guide C; the inclination of this is varied by the reversing lever D, so as to vary the cut-off and to drive the engine in either direction. A radius rod E from the excentric rod operates a rocker arm F, which carries the valve-rod G. In the compound engines the cylinders are tandem, with a single slide valve serving them both.

The farm engines are extensively used in steam ploughing, and can plough twenty-five to fifty acres per day.

The Best Manufacturing Company, of San Leandro has a curious combined traction engine and agri-

cultural machine, which cuts, threshes, cleans, and sacks the grain as the machine travels through the field. These are used in the great wheatfields of California and the North-West. One of these, with a crew of eight men —engineman, fireman, separator man, header man, water hauler, and three sack sewers—performed the work at a cost of 1s. 8d. per acre, with a consumption of 275 gallons of oil fuel per day of ten hours. It has sacked 2750 bushels in a day, and cleared 100 to 125 acres per day. The harvester makes a cut 35ft. wide. This same company also manufactures similar machines to be drawn by twenty to twenty-four mules or horses, and having the threshing and cleaning apparatus driven by a four-cylinder 22 horse-power gas engine mounted within the machine. These make a cut 20ft. wide through the corn, and can cut and thresh forty or fifty acres per day—600 sacks or 1250 bushels—at a cost of about a halfpenny per bushel.

The Best Company's traction engine is peculiar in many ways, and is rated at 100 horse-power. The boiler has a vertical barrel containing the fire-box below and smoke-box above, and from this extends a horizontal barrel containing the tubes. There is a single wheel in front, and a pair of 8ft. driving wheels beside the fire-box. These wheels are 26in. wide, but for soft ground extensions can be bolted on to give a width of 5ft., while in the great areas of swamp lands, or "tules," wooden wheels or rollers 9ft. diameter and 16ft. long are fitted to the driving wheels to keep the machine on the surface. The outboard bearings are supported by an overhead frame. The front wheels in this case are 6ft. diameter and 5ft. wide. In steam ploughing these traction engines have hauled four gang ploughs of four 12in. ploughs each, cutting 8in. deep, at a speed of three miles an hour, and ploughing over sixty acres per day. In one case, with six gang ploughs of six ploughs each, and drills in addition, cutting over a width of 36ft. and at a speed of three miles an hour, from eighty to ninety acres a day have been finished at a cost of 10d. per acre.

The dimensions of the Case Company's traction engines and road locomotives are as follows:—

	Farm traction engine.	Road locomotive.
Rated H.P.	25 H.P.	150 H.P. at 69 lb cyl. press., and 467ft. piston speed.
Brake H.P. (75 H.P. compound)	70 H.P.	
Boiler, diameter	2ft. 8in.	3ft. 6in.
Tubes, number	52	93
,, diameter	2in.	2in.
,, length	8ft. 6in.	9ft. 1in.
Fire-box, length	3ft. 8in.	4ft. 8in.
,, width	2ft. 6in.	3ft. 3in.
,, depth	3ft. 2in.	3ft. 9½in.
Heating surface	232·3 sq. ft.	508·5 sq. ft.
Grate area	8·7 sq. ft.	15·8 sq. ft.
Boiler pressure	130 lb.	160 lb.
Cylinders (compound 9½in. × 11in. and 13in. × 11in.)	11in. × 11in.	14in. × 14in.
Driving wheels, diameter	5ft. 6in.	8ft.
,, ,, face	2ft.	2ft. 6in.
Leading wheels, diameter	3ft. 8in.	4ft. 6in.
,, ,, face	1ft.	1ft. 2in.
Wheel base	11ft. 10in.	14ft. 2in.
Length	—	25ft. 3in.
Width	9ft.	10ft.
Fly-wheel, diameter	3ft 4in.	4ft. 2in.
,, face	1ft.	1ft. 4in.
,, revolutions	250	200
Speed of engine	2½ m.p.h.	2½ and 5¾ m.p.h.

TERSHANA—A TURKISH SHIPYARD.

(From a Correspondent.)

IN Turkish Ters means a ship, Hana means a fabric or works, so that Tershana means the shipyard of the Turkish Government. It is situated along the Golden Horn, beyond the second floating bridge, and at its entrance is the Admiralty Buildings, a square building of Moorish design, where the Minister of Marine and other Pashas do congregate, each attended by his kavass or aide-de-camp. There the German band plays in the afternoon when the minister is in his bureau. There, there is collected a miscellaneous crowd composed of all sorts. Turkish women crowding round the Mazabadjee or cashier of the Admiralty, waiting for pensions that have not been paid for years; officers imploring the payment of only one month's salary; labourers begging for just one medjidere, three shillings and fourpence, in payment in part for a week's work. There also you will see Greek and Armenian contractors begging for something on account of goods supplied and not paid for. The Mazabadjee has a heart of steel. To one he says: "Come back next year about this time." To another he says: "Ben da para yok," which is to say, being interpreted, "I have got no money." To an Armenian merchant he says: "If you won't have patience I will have you put in prison," and so he gets rid of them all. Some are grumbling, and the women are crying. The new Minister is a wit in his way. To one applicant for money he said: "Look here, you may beat me, you may imprison me, you may torture me, you may even kill me; but there is one thing you cannot do, and that is you cannot get any money out of me." The late minister, Hassan Pasha, left a pile of debt to the arsenal, and a large fortune to his numerous wives and children, so that the present minister has to face a multitude of creditors, and a very much reduced revenue.

But to pass through the gates into the arsenal or shipyard proper. The length along the shores of the Golden Horn is about 1½ miles, and on the right are the different stores in which are kept various things suitable for the service, such as ship stores, sail cloth, ropes, old chains, anchors, &c. &c. These stores are in a more or less state of dilapidation. On the left in the Golden Horn there are a number of torpedo boats rapidly going to decay. Amongst the rest may be seen the submarine boats which Nordenfeldt built, now red with rust. They were never used. Passing these we come to a number of old battered hulks, wood and iron, paddle and screw, and in the foreground a collection of old iron which a marine store dealer would be proud of, consisting of old marine boilers, funnels, masts, old marine engines, paddle wheels, propellers, crank shafts, broken down gun carriages, cranes, &c. Also there are the two locomotives that many years ago used to carry the traffic along the railway which runs right through the arsenal. These have retired, and mean to spend the remainder of their days on the universal scrap heap.

Passing on, we now come to what is called the square of Jamalti. On the left we have now something better to look at, for there we see the handsome sheer legs made by Day and Summers and Co., which are still in a good state of preservation. On the right there is the skeleton of a cruiser which was laid down twelve years ago. The frames were set up, and she was partly plated, but in the interval she became obsolete, and is now being cut up and consigned to the scrap heap. Passing on still, on the right we have a collection of buildings, some with roofs, but mostly without, containing a lot of miscellaneous materials, and on the left in the Golden Horn another collection of old shops which an irreverent Englishman called Rotten Row. In the foreground appears the usual collection of old metal. A little further on there is moored the new American cruiser and the one built by Armstrong, and, to bear them company, the fifty-year-old ironclads, which have been repaired, and which have a speed of nine to ten knots. On the right there are some more shops, and the offices of the Chief Constructor of the Turkish Navy. After this we come to the shipbuilding slips, where there is a large shed where ships of 300ft. or 400ft. can be built, but nothing is being done, and the shed is sadly in want of repair. Some smaller boats are on the other slips, but nothing has been done for years, and the unfinished hulks are red with rust. Next we reach a group of buildings consisting of, first, the six-ton steel furnace which was built twenty years ago on the Radcliffe system, and which has been used frequently, but which is now obsolete and falling into ruins. Near this building is the marine shop where, at one time, a good many marine engines were built, but is now idle. On the other side is what is called the Forge, with one or two antiquated steam hammers; and close by it are the pumping engines, auxiliary engines, cylinders, valves, pipes, and other parts of a 3000-ton hydraulic forging press. This machinery was delivered about twelve years ago, and has not been unpacked. On the other side of the square is situated the tube factory, which has a collection of machinery for making steel, iron, and copper tubes, but there is no one to direct it, so it stands idle like the rest. In the middle of this square there is the usual collection of two or three thousand tons of miscellaneous material, including a great number of steel ingots with unknown analysis steel, scrap, old engines, boilers, &c. &c. Near by is the 40-ton Siemens steel furnace, which turned out the base and entablature for the 3000-ton hydraulic forging press twelve years ago. These steel castings lie alongside as they left the moulds. This plant, with its 50-ton steam crane, is rapidly going to decay; it has not been worked for many years. In the same building is the rolling mill, which is also in a state of decay. Passing on we come to the boiler shop, which has a Tweddles' hydraulic plant, also in an out-of-repair condition. This shop is full of unfinished and old boilers, and also miscellaneous scrap; you have to thread your way through it. The machines here as elsewhere are in a filthy state.

Crossing over to the other side we come to the gun factory, the shell factory, and what is called the Fuze factory. This is under the control of a Pasha, whose only qualification is that he was once a naval attaché somewhere. In the shell factory all the shells are made from forgings, although there is a complete plant of machinery for making cast steel shells somewhere; who knows, like other machinery it lies unpacked.

The gun factory was erected to build guns 9in. bore and 35 calibres long, twelve years ago, and during this period it has produced one 6in. gun of 35 calibres, and done some minor repairs to smaller guns. This building is about 300ft. long and 60ft. wide, and is served by a powerful shaft-driven crane of 60 tons. Owing to the great increase in the length of modern guns the machinery is now practically obsolete. A number of old machines have been collected from other parts of the arsenal and put in here.

Outside in the yard there is a very fine steam travelling crane to lift 75 ton, 40ft. from the ground to under the girders. This is of the Goliath type, and if cleaned and painted would be an ornament to the place. It is used for shrinking and oil hardening, and is of the horizontal type. Now for the management. There are forty-six Pashas, an innumerable number of Beys, the remainder being marines and native workmen. There are one or two Englishmen and a few Germans, but all hold inferior positions. At one time there were Englishmen in charge of the boiler shop, the tube factory, the shipbuilding yard, and the marine engine shop. But the fiat of the late minister went forth, and all had to go, and the management was placed in the hands of Turkish officers, with the result I have described.

An Englishman I once met told me that he had called on the late Minister of Marine, who asked him to go through the works and give him his opinion of them when he returned. This he did, and when he returned his Excellency asked him his opinion in Turkish. The Englishman replied in the same language, "Excellency it is a huge scrap heap."

WORK ON THE PANAMA CANAL.

AT a recent meeting of commercial interests at Washington an address was delivered by Mr. Theodore P. Shonts, chairman of the Isthmian Canal Commission, who outlined the work and purpose of the Commission, and from this official address we draw largely for the following information:—At Panama every difficulty is aggravated in an enterprise of the magnitude of the isthmian canal, in which the preparatory work has to be carried on 2000 miles from the base of supplies. But this is not all. The work has to be done in a hostile climate and under health conditions which, through centuries of neglect of all sanitary principles, has become a menace to the lives of all persons save natives of the tropics. In order, therefore, to make the Isthmus a place fit to live in and to work in, there were three fundamental tasks which had to be performed in advance of all others. First, thorough sanitation of the Isthmus; secondly, providing suitable habitations for all classes of workpeople; thirdly, providing a system of food supply which would afford to all workmen opportunity of obtaining wholesome food at reasonable cost.

When the United States began this work there were no systems of waterworks, of sewerage, or of drainage on the Isthmus. Pools of stagnant water had existed for years in proximity to dwellings, and insect-breeding swamps lay undrained adjacent to the cities and many of the towns. Some 70 per cent. of Panama is now supplied with pure mountain water, fed from a storage large enough to furnish 60 gallons per day to each inhabitant after its present population shall have increased one half. Fifty per cent. of a complete modern sewerage system has been installed, and work on the remainder is being carried rapidly forward. The first million of bricks for paving its streets are on the ground. What has been done for Panama is being done for Colon and every important labour camp across the Isthmus.

There are 4100 men now employed in these sanitary undertakings. So effective has been the work that yellow fever has been virtually extirpated from the Isthmus.

To understand fully what has been accomplished by this sanitary work it is only necessary to compare the present rate of sickness with that which prevailed on the Isthmus when the French were in possession. In August, 1882, the second year of the French occupancy, with a force of 1900 men, the death-rate was 112 per 1000. In August, 1905, with a force of 12,000 men, there were only eight deaths, or two-thirds of a man per 1000.

"If we," says Mr. Shonts, "have not, as our critics complain, made 'the dirt fly,' we have 'made the filth fly, and we have made yellow fever, that supreme terror of the tropics, fly so far from the Isthmus that it will never, let us hope, find its way back again. We have established a hospital system which includes a large hospital at Colon and another at Ancon, and a number of smaller hospitals at convenient points along the line."

The Commission inherited from the French company more than 2100 buildings, all in bad condition. During the last year over 500 of them have been repaired; two new hotels, three storeys high and containing from fifty-five to sixty rooms each, have been completed, and authority has been granted for eight others, some of which are under construction at the present time. Work is in progress also on cottages for married workpeople, and on bachelor quarters. In this work of construction 2400 men are employed, and additional carpenters are being sent out with every steamer. This work is being pressed forward with the utmost vigour.

The question of food supplies was one of the most serious problems to be confronted. If the men could not be fed the canal could not be built. Owing to the fact that the natives never look beyond their present necessities, no surplus food supply ever accumulates. This normal condition of no surplus was greatly intensified by the almost total failure of the crops for the two preceding years; by the abandonment by agricultural labourers of their farms back in the hills for work on the canal, where they received higher pay for shorter hours; and by quarantine against the port of Panama on account of bubonic plague, which prevented the arrival of foodstuff from neighbouring provinces.

It was, therefore, arranged to open local commissary stores at every important labour camp, to provide mess-houses, and to furnish food, both cooked and uncooked, to all workpeople at cost. Steamers were equipped with refrigerating plants, and arrangements made for the erection of a temporary cold storage plant at Colon; railway refrigerator wagons were purchased for immediate shipment to the Isthmus, thus establishing a line of refrigeration from the markets of the United States to the commissary stations of the Isthmus. The net result of these efforts is that to-day all workmen are afforded opportunity to obtain an abundant supply of wholesome food, cooked and uncooked, at reasonable prices.

The only really valuable instrument essential to canal building acquired by our Government in its purchase from the French was the Panama Railway. But this instrument, like all the others whose wrecks cover the Isthmus, had been neglected and its equipment allowed to become obsolete. If the docks, wharves, warehouses, terminal yards, locomotives, and cars of the Panama Railway had been in good repair, which they were not, they still would have been entirely inadequate properly to care for and handle the small commercial business the line was transacting. The existing facilities, poor as they were, were rendered less efficient by the entire absence of any mechanical appliances on the docks to assist in receiving or discharging the steamers' cargoes.

It was necessary, consequently, to begin at once the construction of new wharves equipped with modern appliances, and of large terminal goods yards at both ends of the railway; of extensive warehouses; of suitable machine shops, and of a modern coal hoisting plant, which is said to reduce the cost of handling coal from ship to engines from 5s. 7d. to about 6d. per ton.

New and more powerful locomotives, larger carriages and wagons for passenger and goods services, and heavy steel rails for re-laying the road, have been purchased, and the bridges have been strengthened to enable them to carry the heavier equipment. The *personnel* of the line has been reorganised, with excellent results.

While all this necessary work was in progress, the task of purchasing, forwarding, and distributing the enormous quantity of materials and supplies of all kinds was receiving constant and most careful attention. To give an idea of the magnitude of these purchases, it is stated that 61 steam shovels or excavators, 1300 platform wagons, 12 rapid unloaders, 22 unloading ploughs, 13 earth spreaders, 324 dump wagons, 12 hoisting engines, 120 locomotives, 5000 tons of steel rails, 125,000 sleepers, 12,000 pieces of piling, 14 air-compressing machines, 3 cranes, 152 rock drills, 30,000,000ft. of lumber—approximately—2 dipper dredgers, 646,000 lb. of blasting powder, 617,500 lb. of dynamite, 7,000,000 paving bricks, 3,500,000 building bricks, 500,000 square feet roofing tiles, 36,000 barrels of cement, 3 steel water tanks and towers, 12 stand pipes, and 2 ocean steamships have been bought. The approximate total cost of the purchases was about £1,800,000.

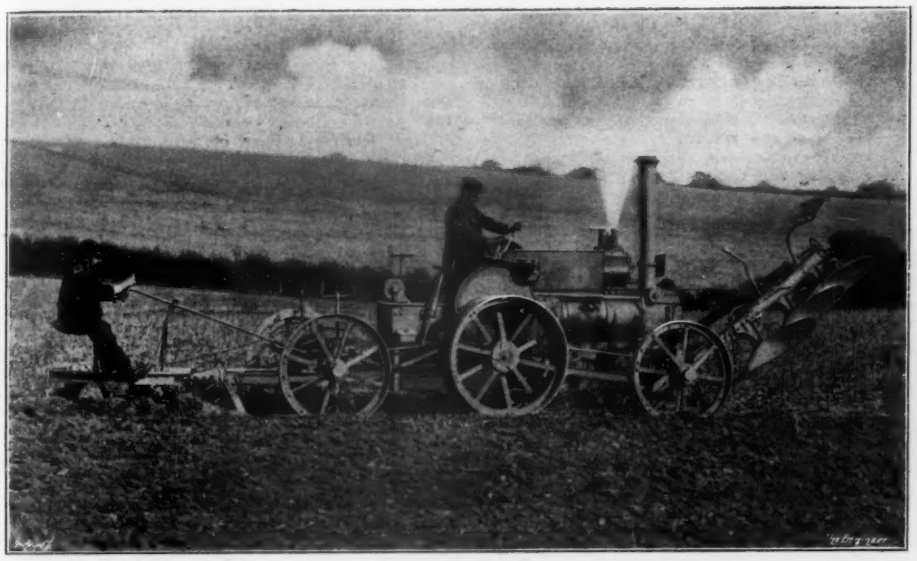
So far as actual excavation and dredging are concerned, it has not been endeavoured to accomplish much. Six steam shovels are now working in Culebra cut, which is the largest single factor in the construction of the canal. These have removed approximately 1,000,000 cubic yards of material. By this work two things are being accomplished:—First, the levels of the cutting are being put in proper condition for the installation of the largest number of machines which can be effectively operated; and, secondly, data which will be useful in future estimates of the cost of canal construction are being compiled. In the Culebra work 2600 men are now employed.

The application of the eight-hour law, of the contract labour law, of the Chinese exclusion Act, or of any other law passed, or to be passed, by Congress for the benefit of American labour at home, to labour on the Isthmus would, continues the report, be a serious error. Over 80 per cent. of the workmen of the canal will be aliens. A majority of the other 20 per cent. employed will be in a clerical or supervisory capacity. The application of those laws on the Isthmus would benefit a small number of American labourers, but would enormously add to the cost of construction, and American labour at home would have to pay its share of the consequent increase in taxation.

It is the confident belief of the Commissioners that by the 1st of July next the plant, as purchased, will be installed and working to its fullest practical capacity. In other words, by that time the dirt will begin to fly in earnest.

THE SMITHFIELD SHOW.

As a *rendez-vous* for farmers, stock-breeders, and agents for and manufacturers of agricultural implements—in the widest interpretation which can be placed upon the term "agricultural"—the Smithfield Club's annual Exhibition at Islington continues to fulfil its mission. Whatever be the vicissitudes of kindred institutions, there appears to be no difficulty in allotting all the space at the Club's disposal in the Agricultural Hall. With comparatively few exceptions, we have the same firms, whose names are almost as familiar as the makers of well-known soaps, in the same positions each succeeding year, though their representatives change. That the British farmer is conservative in the choice of his implements, and therefore difficult to divert from the beaten track, is, perhaps, only half the reason for the fewness of novelties which agricultural implement makers bring to their notice. Those interested in this branch of mechanical engineering have long ago ceased experimenting to any considerable extent, and now confine themselves to perfecting trifling details and improving the quality of their productions. Thus it is that to the casual observer the exhibits at this year's Show differ but slightly from those seen at several of its predecessors. A closer inspection will, however, bring to light little departures in practice which are the result of experience and keen competition. In the building of ploughs, for instance, it might be considered that "the last word" had long ago been uttered, and that no room is left for improvement. This is not the case, as a visit to the stands of several exhibitors demonstrates. Messrs. J. and F. Howard, of Bedford, show two ploughs, one of which has been designed specially for haulage by an agricultural motor in place of horses. It is a three-furrow implement. Another plough, for two furrows, shows framework which has been materially stiffened, and instead of its longitudinal members being stayed by angular struts, the whole has been arranged on a more rigid principle in rectangular fashion. John Wallace and Sons, Limited, Graham street, Glasgow, show a combination of a double-drill plough and manure distributor specially applicable to turnip and potato farming. This machine is made to open two drills and to distribute artificial manures in the bottom of them. It is operated by two horses and one man, and the rotary distribution of the manure can be adjusted within wide limits.



WALLIS AND STEEVENS' STEAM TRACTOR AND PLOUGH

A distinct departure in ploughs is shown by Wallis and Steevens, Limited, Basingstoke. This firm has for some considerable time made a speciality of a light steam tractor familiar to most of our readers, and the present exhibit is an attempt to render this handy machine of more general use to the farmer than for road purposes only. With this object they have devised a plough, fitted to either end of the machine, as shown in the illustration on this page, so that they can be readily attached or removed. The idea is to run the engine backwards and forwards hauling one or other ploughs after it. When moving forward the front plough is raised by screw tackle and chains by the driver, and only the rear plough is used. When the engine is moving backwards the front plough is lowered, and the rear plough raised out of the ground. An extra man rides on the plough, and, by means of suitable gear, controls the steering of the engine. Although of only small dimensions, it is said that this motor is sufficiently powerful for hauling a three-furrow plough, and that "an average of five to six acres per day can be worked at a cost of twenty shillings, including interest on capital, depreciation and repairs, &c." It would, however, appear that the size of the headlands must be unusually large, owing to the difficulty of avoiding the newly-made furrows when reversing, and that there will be less adhesive force on the drivers on the backward movement than on the forward motion, due to the downward pull of the plough on the steering wheels. Moreover, there is the objection common to other systems of motor ploughing, that the weight of the engine on some lands will render the portions which come immediately under the wheels too hard for successful cultivation.

Steam ploughing engines are shown by John Fowler and Co. (Leeds), Limited, and Messrs. Aveling and Porter, of Rochester. The engine shown by the former firm is a compound for working on the double engine system of cultivation with hauling drum and self-acting coiling gear for wire rope. It has been built to order, and has massive driving wheels, 6ft. diameter by 22in. wide; steering wheels, 5ft. diameter by 16in. wide; winding drum and gearing of cast steel. The engine has all the recent improvements introduced by the makers in their ploughing and traction engines. Steel is largely employed in these engines. The boiler is provided with easy access for cleaning, and is designed for a working pressure of 180 lb. Messrs. Aveling and Porter's ploughing engine is also designed to work on the double engine principle with removable coiling gear. It is of the compound type, and is convertible into a traction engine by taking down the coiling gear, and bringing the steering wheels and front axle further under the barrel of the boiler, where a second saddle is provided. For stationary work, such as driving farm machinery, a belt can be driven from the fly-wheel. A road locomotive and motor tractor are also shown on this stand. The latter comes within the five-ton tare limit, and has road wheels designed to meet the conditions laid down by the Motor Car Act. Several other firms show light steam tractors of this description, including Clayton and Shuttleworth, Limited, Lincoln; Chas. Burrell and Sons, Limited, Thetford; Richard Garrett and Sons, Limited, Leiston; and Ruston, Proctor and Co., Limited, Lincoln. Ransomes, Sims, and Jefferies, Limited, Ipswich, have a variety of implements, and road locomotives, portable and fixed engines. A 6 nominal horse-power traction engine of the compound type mounted on springs, with link motion and accessible valves, is worthy of special mention. Other makers of traction engines confine their exhibits to standard types. These include Messrs. J. and H. McLaren, Leeds; Marshall, Sons and Co., Limited, Gainsborough; and Mr. William Allchin, Northampton. The 7 horse-power compound traction engine of Marshalls is of their new type, with three speeds, constructed to work with economy in steam consumption and fuel, and every attention has been paid to its construction to make the engine as simple and efficient as possible. This engine is fitted with a small horizontal steam pump outside the tender above the road wheels, in addition to an injector. It also has springs fore and aft, rim brakes to both hind wheels, and side guards over the working parts.

The display of oil engines is up to the average. The exhibitors include Messrs. Allan Brothers, Aberdeen, who show a horizontal 10 brake horse-power engine with a special filter on the induction side to prevent dust entering the vaporiser, and an appliance for injecting water into the cylinder with the charge. The water is taken from the cylinder jacket. Blackstone and Co., Limited, Stamford; Brown and May, Limited, Devizes; the Campbell Gas Engine Company, Limited; Crossley Brothers, Limited; Rd. Hornsby and Sons, Limited; J. B. Petter and Sons, Yeovil; Fielding and Platt, Limited, Gloucester; and Davey, Paxman and Co., Colchester, all show internal combustion engines for use with heavy hydrocarbon oils. The last-named firm also shows a vertical 6 brake horse-power single cylinder petrol engine which works on the four-cycle system, and is designed with a view to ease of access. The engine frame is cast complete with the water jacket, the cylinder liner being put in loose from the top, and all the valves are contained separately in the combustion chamber, which is firmly secured to the main frame by studs. The vapour valve has positive action, and is controlled by a rotary governor on the hit-and-miss principle, accurate governing being thus obtained, as upon an excess of speed the valve is not opened. There is a separate admission valve for admitting a slight amount of air only, this being automatic in action. The ignition is effected by means of battery and trembler coil.

Steam motor lorries are shown by Messrs. E. S. Hindley and Sons, Limited, Bourton, Dorset; the St. Pancras Ironworks Company, Limited; and Savage Brothers, Limited, King's Lynn. Messrs. Hindley's wagon is fitted with a composite resilient wheel, which has been found to give satisfaction, and enables the users to take advantage of the extra speed allowed in such cases by the Act. The boiler adopted in this vehicle is of a modified locomotive type in which the whole of the tubes are submerged under practically all conditions. The St. Pancras Company's wagon is practically identical with that described some time ago in THE ENGINEER. With the exception that a water-tube boiler is now used, a slight enlargement of the high-pressure cylinder bore and the fitting of D slide valves. Messrs. E. R. and F. Turner, Ipswich, are represented by portable, horizontal, and vertical engines, and their well-known corn-grinding and crushing mills.

The show closes to-day, Friday.

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS.—A general meeting will be held in the Wood Memorial Hall, Newcastle-upon-Tyne, at two o'clock, on Saturday, December 9th.

WHAT LEEDS OWES TO MECHANICAL INVENTION.—Some 200 members and guests of the Leeds Association of Engineers assembled at the Queen's Hotel on Saturday evening last for their fortieth annual dinner. Ald. A. Tannett-Walker was the chairman, Mr. H. M. Butler occupied the vice-chair, and the gathering included:—The Lord Mayor, Mr. E. Woodhouse; the Vicar of Leeds, Dr. Bickersteth; Mr. Roland Barran; Mr. J. H. Wicksteed; M. A. H. Meysey-Thompson; Mr. F. W. Lawson; Mr. T. P. Reay, Mr. W. Deighton; Mr. E. E. Lawson; Mr. J. McLaren; Mr. H. McLaren; Mr. W. H. Drake, president of the Association; Mr. J. Scriven, vice-president; and Mr. Robert Lupton, secretary. "The City and Trade of Leeds" was proposed by Mr. J. H. Wicksteed, who, after contrasting Leeds as shown on a map of 130 years ago with the present city, said that in that period one trade had sprung up, which was the reason why Leeds had grown ten times, if not 100 times, more in one century than it had grown since, say, the time of the Romans. That was the trade in which they were engaged—the art and practice of engineering. The inventions of last century had added ten times to the result of human effort. "The best of it all," said Mr. Wicksteed, "is that the more machinery adds to human comfort, the more employment there is for humanity. There are a great many things done now which expand the world, and give employment to a good deal more industry, which could not be done if it were not for machinery." The Lord Mayor, Mr. E. Woodhouse, responded, remarking that he thought Leeds could be said to have prospered as much, if not more than, any city in the country during the last twenty or twenty-five years. He took it that, as engineers they had derived a great and permanent benefit from the Leeds University.

SOCIETY OF ENGINEERS.—At a meeting of the Society of Engineers held at the Royal United Service Institution on Monday evening, a paper was read on "The Grindleford Stone Quarries and their Working" by Mr. Benjamin L. Bradley. He explained that the Grindleford quarries have been started in connection with the Derwent Valley Water Scheme. The quarries supply the stone for building the dams. They are 10 miles from Sheffield, and in extent cover 52 acres. Their geological formation comprises the millstone grits of the carboniferous system known as the Rivelin. The approximate quantity of good building stone is 2,400,000 tons. The quarries were opened in 1902, and the first consignment of stone was despatched to the dams on June 13th, 1903. The quarries are connected to the Midland Railway system, and owing to the high altitude of the working faces—which is about 500ft. above that line—extensive preliminary works were necessary. They consisted of an incline rope haulage cableway 750ft. long, having a gradient of 1 in 3; a zig-zag railway with a gradient of 1 in 25 from the summit of the cableway to the stone-working faces; working branches from the main line; and workmen's dwellings and workshops. The plant and machinery for working the quarries includes four locomotives—two 12-ton, nine 7-ton, and one 5-ton steam travelling cranes, including the locomotives for feeding the cableway and quarries with trucks. There are 140 wagons for conveying material and 160 tipping wagons for rubble, besides 50 tip wagons for removing spoil and *débris*. The cranes are used for pulling the rock out of the faces and loading it on the wagons. The water supply for the machinery and workshops is obtained from a stream 360ft. below the top working faces of the quarry. It is raised by means of a hydraulic ram capable of lifting 16,000 gallons in twenty-four hours, the amount required being 12,000 gallons per day of ten hours. The author further gave a detailed description of how the quarries are worked, and also dwelt at some length upon the explosives used. In conclusion he gave the costs of the preliminary works and of quarrying operations on the tonnage output.

ROYAL INSTITUTION.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, in the chair. Lieut. E. P. C. Amphlett, Mr. F. Bailey, Mr. H. Behrens, Mr. J. Kennedy, Mr. J. N. Kerr, and Dr E. M. Modi were elected members. The special thanks of the members were returned to Dr. Ludwig Mond, Ph.D, D.Sc., F.R.S., for his donation of £500 to the fund for the promotion of experimental research at low temperatures. It was announced from the chair that the managers had elected Professor William Stirling, M.D., LL.D., D.Sc., Fullerian Professor of Physiology. The following are the lecture arrangements at the Royal Institution before Easter:—A Christmas course of six illustrated lectures, adapted to a juvenile auditory, by Professor H. H. Turner, on "Astronomy"; Professor E. H. Parker, three lectures on "Impressions of Travel in China and the Far East"; Professor William Stirling, six lectures on Physiology subject; Dr. J. E. Marr, three lectures on the "Influence of Geology on Scenery" (the Tyndall Lectures); Rev. Canon Beeching, two lectures on "Shakespeare"; Mr. Benjamin Kidd, two lectures on the "Significance of the Future in the Theory of Evolution"; Mr. H. B Irving, two lectures on the "English Stage in the Eighteenth Century"; Mr. Francis Darwin, three lectures on the "Physiology of Plants"; Professor B. Hopkinson, three lectures on "Internal Combustion Engines," with experimental illustrations; Mr. J. E. C. Bodley, two lectures on the "Church in France"; Mr. J. W. Gordon, two lectures on "Advances in Microscopy"; Mr. M. H. Spielmann, two lectures on "George Frederick Watts as a Portrait Painter"; and Professor J. J. Thomson, six lectures on the "Corpuscular Theory of Matter." The Friday evening meetings will commence on January 19th, when Professor J. J. Thomson will deliver a discourse on "Some Applications of the Theory of Electrical Discharge to Spectroscopy." Succeeding discourses will probably be given by Professor S. P. Thompson, Mr. H. F. Newall, Mr. W. C. D. Whetham, Dr. R. Caton, Dr. Hutchison, Sir Andrew Noble, Bart., Professor P. Zeemann, Mr. W. B. Hardy, and other gentlemen.

THE CROWNING WORK OF THE SIMPLON TUNNEL.

THE great engineering task of constructing the Simplon Tunnel is at last complete. The track and the line equipment alone remain to be finished. The masterpiece in the construction of the whole tunnel, as distinguished from the actual work of boring, is situated between the kilometric points 4450-4492 on the Italian side, where the soil traversed is of saturated decomposed clay slate. The history of the passage through those 40 m. of soft material constitutes probably the most interesting of the Simplon Tunnel enterprise. At the present moment it is the most imposing piece of constructional work to be met with from end to end of the main gallery.

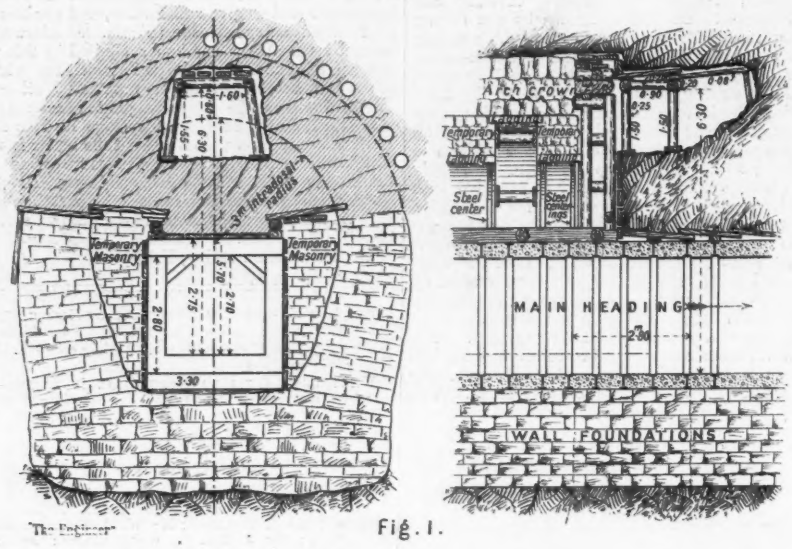


Fig. 1.

All details of the earlier stages of this work were described in THE ENGINEER, January 9th, 1903, pages 30, 31, and 32, and on September 11th, 1903, pages 250 and 254. At the period when those notes were written the definite plans for the construction of the vault had not been prepared. The method of building this arch ring, about 6½ft. in thickness, and of over 15ft. extradosal radius, has, therefore, not been, so far, described in these pages. The accompanying drawings and engravings show

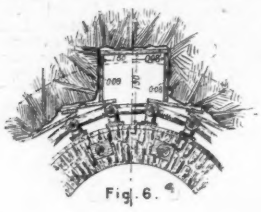


Fig. 6.

the means which were employed for this very difficult operation, and which were proved to be of such efficiency and simplicity that they elicited the admiration of foreign tunnel experts who had the good fortune to see this work in progress. The enormous pressure to be supported during the excavation for the crown of the tunnel necessitated the most solid description of temporary masonry work—granitoid rock set in cement mortar—in order to provide a sufficiently solid basis on which to step the crown timbers. Even in the relatively small surfaces subject to pressure in the main heading, the iron girder frames, 40 cm. deep and measuring 3·30 m. wide by 3·50 m. high, were very badly crushed, and in some cases torn like pieces of paper, as is shown by some of the illustrations given. In a span of 6 m., as represented by the extrados of the temporary arch masonry, the stress was such that the steel centres would have had to be of proportions which would have rendered transport very inconvenient, whereas all the materials for the construction of stone centerings were readily available and easily carried.

The complete success of all the operations was proof of the excellence of the means. These were planned under the superintendence of Herren Brandau and Pressel directing the work at the south side of the tunnel. This, however, does not comprise the armouring of the advance heading, already described in detail, the conception of which, together with the adoption of rolled I sections, 400 mm. deep, were due to the directing engineer of the north side, Herr Colonel E. Locher. The whole of the extremely arduous and very risky work at this spot was carried through under the direct supervision of Chief Engineer Pressel. The conditions were such that only the most vigilant caution and extraordinary care in every operation prevented the occurrence of accidents involving the lives of everyone in the workings. The aptitudes and qualities required of the men employed here were of a very different nature to those of the miners operating in the advance headings; and the choice of the operatives no doubt accounted for the remarkable fact that this work was carried through without constructional accidents of a serious kind. As will be observed from the sketches, the excavations were limited to small areas, and shored up foot by foot as the enlargement proceeded. Cooped up in small holes, illuminated with miners' hand lamps and ventilated with difficulty, the impediment to the handling of the heavy timbers required was exceptionally great; and the black sandy mud, speedily covering or plastering everything introduced into the excavations, added to the ever-present chances of accident. The danger of being entombed at any moment while scooping a way through the saturated mass was occasionally demonstrated by the heaviest timbers being riven to fragments beneath the incalculable pressure of the soil, or by the announcement of the iron girder frames yielding under the strain, by the shorn bolt heads or nuts flying off with reports like the crack of a gun, the same projectiles sometimes injuring men in their trajectory.

The whole work looks very simple to execute on paper, but only indefatigable patience and prodigious efforts, physical and mental, under the most cheerless of conditions, enabled the plans to be carried through with success. So far the colossal lining of the tunnel between kms. 4450-4492 has been more exempt from movement than has the lining in many parts where the natural rock presented far less difficulty.

A short explanation of the operations for the construction of the arch crown will no doubt be of interest. Starting from the stage in the operations already described in 1903, the commencement was made, as shown in Fig. 1,

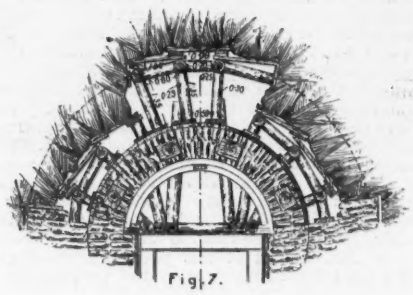
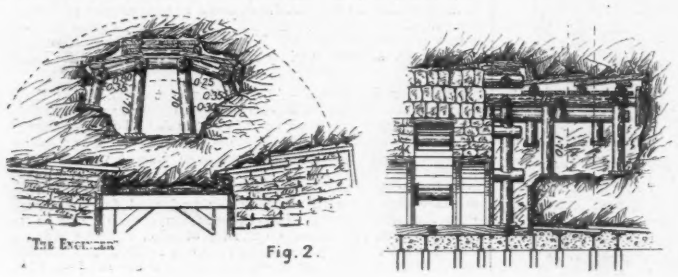
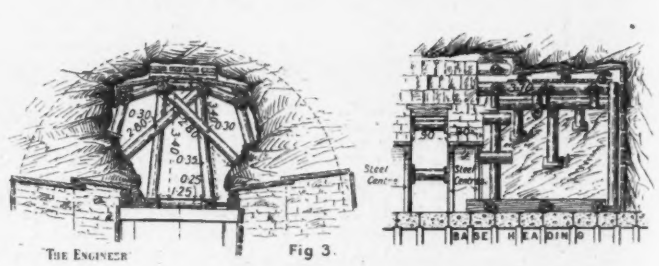
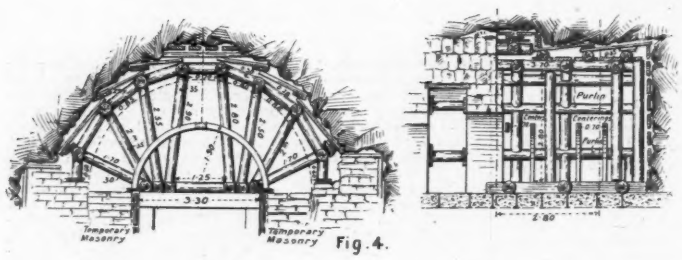


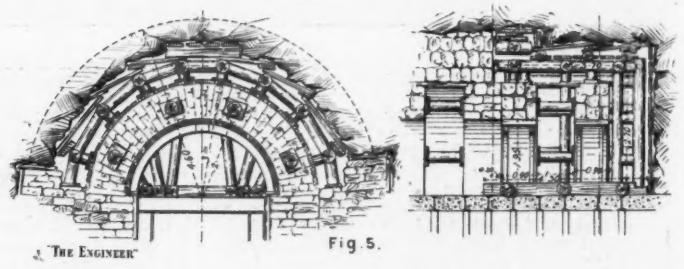
Fig. 7.

with a crown drift as a continuance of previous operations for the erection of temporary masonry centres. A more advanced stage of the work is exhibited in Fig. 2. As the excavation proceeded in length and in width, the timbers were increased in length until the main posts rested upon the top of the squared bearers laid across the girders of the base heading, as visible in the sections, Fig. 3. As the shelf on either side was gradually lowered, the temporary struts were knocked out and replaced by radial pin posts, until the whole of the arch timbering was complete, as in Fig. 4. Two sets of steel arch centres were then aligned on wedges with 70 cm. interval between the longitudinal centres of each set, and 1·10 m. distance between the inside faces of each group. These light centerings, of I-section, have a depth of only 20 cm. and a breadth, across the flange, of 10 cm. The two sets


"The Engineer" Fig. 2.


"The Engineer" Fig 3.


Temporary Masonry Temporary Masonry Fig. 4.


"The Engineer" Fig. 5.

described in THE ENGINEER, January 9th, 1903, pages 30, 31, and 32, and on September 11th, 1903, pages 250 and 254. At the period when those notes were written the definite plans for the construction of the vault had not been prepared. The method of building this arch ring, about 6½ft. in thickness, and of over 15ft. extradosal radius, has, therefore, not been, so far, described in these pages. The accompanying drawings and engravings show tunnel. This, however, does not comprise the armouring of the advance heading, already described in detail, the conception of which, together with the adoption of rolled I sections, 400 mm. deep, were due to the directing engineer of the north side, Herr Colonel E. Locher. The whole of the extremely arduous and very risky work at this spot was carried through under the direct supervision of Chief Engineer Pressel. The conditions were such that only the most vigilant caution and extraordinary care in every operation prevented the occurrence of accidents involving the lives of everyone in the workings. The aptitudes and qualities required of the men employed here were of a very different nature to those of the miners operating in the advance headings; and the choice of the operatives no doubt accounted for the remarkable fact that this work was carried through without constructional accidents of a serious kind. As will be observed from the sketches, the excavations were limited to small areas, and shored up foot by foot as the enlargement proceeded. Cooped up in small holes, illuminated with miners' hand lamps and ventilated with difficulty, the impediment to the handling of the heavy timbers required was exceptionally great; and the black sandy mud, speedily covering or plastering everything introduced into the excavations, added to the ever-present chances of accident. The danger of being entombed at any moment while scooping a way through the saturated mass was occasionally demonstrated by the heaviest timbers being riven to fragments beneath the incalculable pressure of the soil, or by the announcement of the iron girder frames yielding under the strain, by the

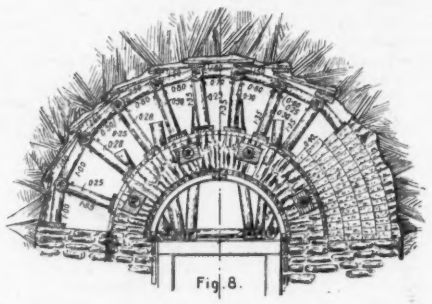


Fig. 8.

of centres are shown in perspective in the engraving, Fig. 9. The temporary arch, or masonry centre, is shown built half way up on either side. The radial posts supporting the natural crown had been replaced at the middle by shorter posts bearing directly on the steel centres, these latter being thus loaded down with the weight ultimately to be borne by the masonry centres. The last completed section of the tunnel crown, as also the lagging boards at the end of the drift, are visible in the same view; for the length of the excavation ahead of the fully completed arch ring never exceeded 4 m. or 4¼ m., which length

CROWNING WORK OF THE SIMPLON TUNNEL

Fig. 9—BUILDING TEMPORARY ARCH CENTRES

Fig. 10—DIFFICULTY IN ERECTION OF STEEL FRAMES

Fig. 11—MINING THE TEMPORARY ARCH MASONRY

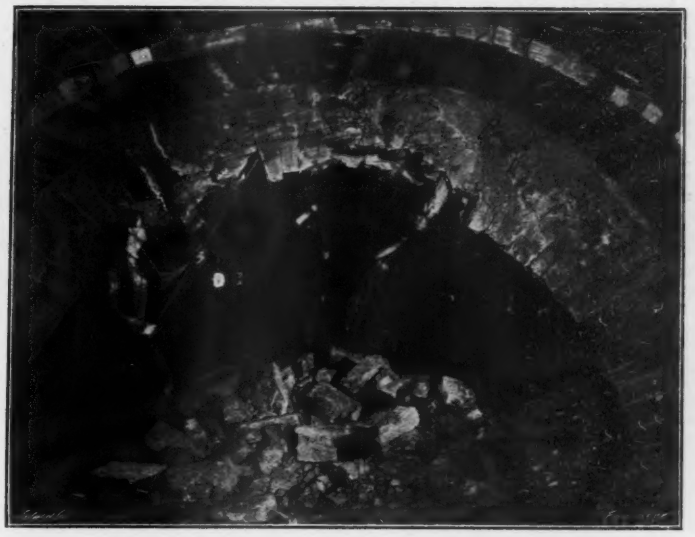


Fig. 12—DEMOLITION OF TEMPORARY ARCH MASONRY

Fig. 13—DEFORMATION OF IRON GIRDERS

Fig. 14—INFLOW OF WATER

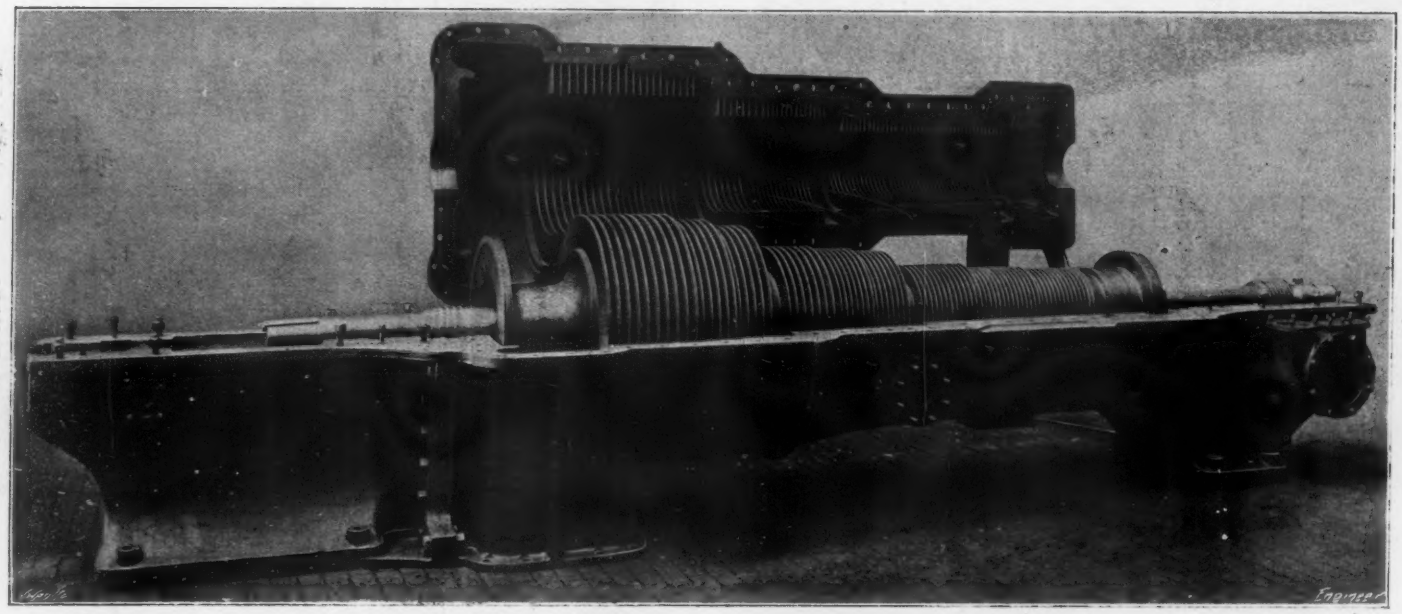
was sufficient for the building of two temporary masonry arches, each having a width of 1 m., with an interval of 1 m. between each. These intervals were maintained against the longitudinal pressure—transmitted to them through the horizontal timbers in the advance drift—by means of the four short pieces of timber noticeable in all the sections. One end of the timber butted against a slab of wood, distributing the pressure on the wall, and the opposite end was made tight by means of wedges. The boards supporting the masonry on the steel centres were stout scantlings of about 4in. square. The completed masonry centerings are shown in the section, Fig. 5. In these details are also illustrated the first stages of work for the enlargement of the area above the temporary masonry ready for the building of the great arch ring. Here the stump posts for the arch timbers bear upon the masonry centerings through the intermediary of 4in. extradosal boards.

In the view Fig. 6 a crown drift has been started, and in the view Fig. 7 it has been enlarged downwards, following the contour of the eventual extrados of the tunnel crown. The entire excavation is shown completed in the view Fig. 8, left-hand side; and on the right-hand side the progress of building the four courses of voussoirs is shown, together with the extradosal filling of ashlar. The arch ring, in the intervals between each temporary arch, was built on heavy lagging boards bridging these spaces.

The masonry which served for the erection of the heavy arch ring was demolished early in the year 1904, and the operations of mining this are shown in the flash-light view Fig. 11. The imprints of the heavy timbers used for the longitudinal support of the provisional arches are visible on the face of the masonry. The work of demolition was continued with hand bars—Fig. 12. A general view of these operations in February, 1904, is given in Fig. 13. The deformation of the iron frames of the base heading is noticeable in the same illustration. The incursions of water in the immediate

1000 K.W. STEAM TURBINE

WILLANS AND ROBINSON, LIMITED, RUGBY, ENGINEERS



neighbourhood of the section, kiloms. 4450-4492—one of which is shown in Fig. 14—were not without influence upon the conduct and progress of the work in this most difficult part of the Simplon Tunnel.

An estimate of the enormous pressure of the decomposed mica schist in the section under mention may be formed from the accompanying sketches—Fig. 15—made of the iron beams after they had been removed from the tunnel. Drawings of these frames and their assemblage with oak beams were given on page 32, January 9th, 1903. The rolled sections of which they are formed are 40 cm. deep, 15½ cm. breadth across gauge, and 1½ cm. thick in the web, and they weigh 90 kilos. per metre run. Their erection in the tunnel—see Fig. 10—was, in general, difficult of accomplishment, and when crushed and broken by the external pressure their replacement by others was also very difficult. A close study of some score of these broken or deformed girders from the caps, the footings, and posts of the quadrangular frames could alone convey an adequate idea of the pressure which they had to withstand in the tunnel. The results proved that oak was too yielding in use in conjunction with iron. As a matter of fact, with the exceptional stress to which they were subjected, the combination of wood and iron frames did not entirely give the results anticipated therefrom; but where the I-beams were embedded in concrete a greater resistance resulted, and in tunnel No. 2 the experience gained in the main heading No. 1 was turned to good account for the auxiliary gallery.

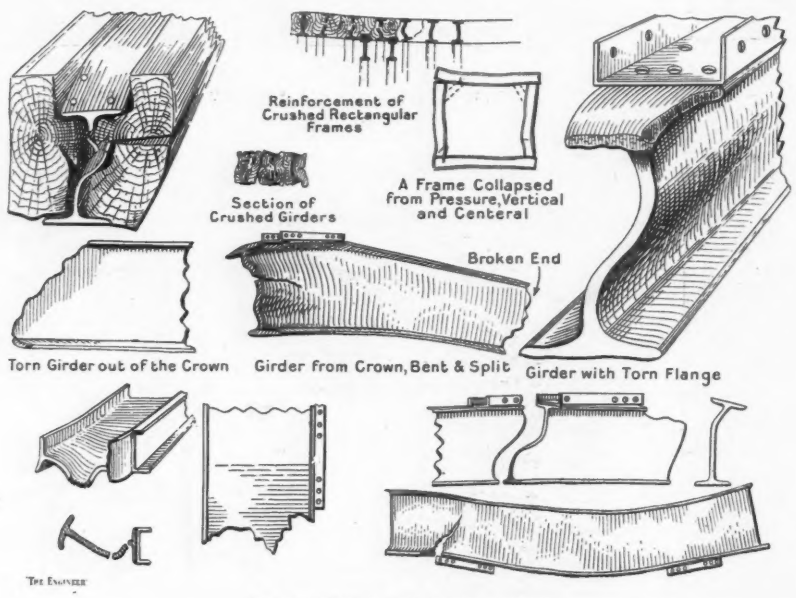

Reinforcement of Crushed Rectangular Frames
Section of Crushed Girders
A Frame Collapsed from Pressure, Vertical and Centeral
Broken End
Torn Girder out of the Crown
Girder from Crown, Bent & Split
Girder with Torn Flange
The Engineer

Fig. 15—BROKEN AND BENT GIRDERS

The engravings illustrating this article are reproduced from a series of photographs taken by the chief engineer of constructional work, Dr. Konrad Pressel, and his wife, Madame Pressel, a Russian lady who, in Caucasian costume, has followed the operations in the Simplon Tunnel from the commencement, and has been present during some of the most alarming incidents of the work at the south side. To Dr. Pressel our best thanks are due for these photographs.

TURBINE-DRIVEN PAPER MILL PLANT.

In our issue of July 18th, 1902, we described the electrical installation in the Linwood Paper Mills, Renfrewshire. This plant has, we understand, worked so satisfactorily that the proprietors ordered a 1000-kilowatt steam turbine set for driving two continuous current dynamos. This turbine engine is now being placed in position, and it will, it is anticipated, bring about a further reduction in the cost of working the mill. Without the turbine the first installation showed a marked superiority over the old steam-driven plant.

The average cost per unit taken over a month is recorded as follows:—

Coal	·148d.
Oil, waste	·013d.
Wages	·022d.
Repairs, 2½ per cent. on £10,000	·022d.
Works cost	·205d.
Five per cent. interest on £10,000	·044d.
Ten per cent. depreciation on above	·088d.
Total cost per unit	·337d.

The units generated per week for the four weeks under consideration were 64,000; 57,090; 44,190, and 50,880.

The engine-house holds two 250-kilowatt dynamos, the high-speed engines being triple-expansion, and working with a boiler pressure of 250 lb. per square inch at the stop valve, the steam being superheated to give a temperature of 500 deg. Fah. at the engine. By means of jet condensers, a vacuum of 25in. to 25½in. is obtained at the engines. Each steam dynamo runs about 128 hours per week, the output at night being only slightly less than that during the daytime. The staff is divided into two shifts, which work twelve hours each, each shift consisting of one engine-driver and one stoker.

Two boilers of the Babcock type are installed, and have each 3590 square feet of heating surface; the furnaces have chain grate stokers, and the boilers have their own superheaters.

The motor equipment consists of eight 80, two 50, and ten 25 brake horse-power motors. Six of the 80 horse-power motors drive the beating engines. The two paper-making machines have two motors each, a 25 and a 50 brake horse-power, and two 25 brake horse-power motors respectively. Several of the motors in these mills are geared up to the various machines. Pinions made of paper are used for the motor gears, discs being cut from the web and built up like an armature core.

The steam turbine now installed is the parallel-flow Willans-Parsons steam turbine, which differs slightly in details of design and manufacture from the Parsons standard type. Special attention has been given to the arrangement of necessary details, such as governor gear, oil pump, steam and water piping, &c. To enable quick inspection of the turbine the top half of the casing has been arranged with two hinges, and it is stated that it is possible for two men to remove the main bearing caps and to open up the turbine for inspection in less than an hour. The blades for one complete ring are built up on two half rings, and these half rings are then caulked into the shaft or the casing. All the turbines are fitted with by-pass valves, which automatically open when the maximum economical output of the turbine is exceeded, and by means of these valves any required overload can be obtained up to the full capacity of the generator.

Physical Society.—The Physical Society is to hold an exhibition of electrical, optical, and other physical apparatus at the Royal College of Science, South Kensington, on December 15th, 1905, from 7 to 10 p.m. The following is a list of the exhibits:—A spherometer, proof glasses showing interference method of testing optical surfaces, a photographic lens testing bench, a diffraction grating direct spectroscope, a pocket direct-vision diffraction spectroscope, a microscope specially designed for metallurgical work, and a microscope for petrological work; all the foregoing being exhibited by Messrs. R. and J. Beck, Limited. An Einthoven string galvanometer, a Duddell thermo-galvanometer, a Duddell twisted strip ammeter, a Broca galvanometer, a Dolezalek electrometer, a Grassot fluxmeter with large permanent magnet for demonstration, and Duddell magnetic standard; a Cadmium cell—H form—a bridge for teaching resistance thermometry, a new form of recording thermo-couple, a Melloni bench, a spectrometer, a telescope and scale, an astronomical micrometer, a Trouton hygrometer, a vertical sonometer, Perry's apparatus for teaching law of helical springs, a Burton levelling stand, and stands for holding apparatus with universal clamps and time markers—Deprez and simple double marker—these being shown by the Cambridge Scientific Instrument Company. An electrometer, devised by Mr. W. A. Price, M.A., an electrical pyrometer of the thermo-electric type, for engineering measurements, and a set of laboratory standard resistances, by Messrs. Crompton and Co. Electrical measuring instruments, by Messrs. Elliott Brothers. A portable photometer, a watt-photometer, a standard photometer, ammeters and wattmeters, and a frequency indicator, by Messrs. Everett, Edgcumbe and Co. A large spectrograph fitted with optical parts made of ultra-violet glass, a spectrograph of smaller pattern, a solar spectroscope of the Evershed pattern, and a large direct-vision spectroscope of new design, by Mr. Peter Heele. A spectroscope, measuring in wave-lengths direct, and a standard goniometer, by Messrs. A. Hilger. Marconi's Wireless Telegraph Company will show Dr. Fleming's cymometer, for making exact measurements of wave-lengths and frequencies in wireless telegraphy, or in similar high-frequency circuits; demonstrations will be given with this instrument. Messrs. Nalder Bros. and Thompson, a portable standard testing set, with ohmmeter and generator; and Messrs. Newton and Co., projecting lanterns for projecting both apparatus and slides, polariscopic and microscopic preparations, induction coil and other X-ray apparatus, comprising all that is needed for a hospital or private experimenter; demonstrations will be given at intervals. Universal pyrometers and a small electric muffle furnace, Duddell-Mather standard wattmeters gauze resistances, a reflecting galvanometer, vibrationless, with new pattern scale and Nernst lamp; galvanometers of the single pivot portable type, electrostatic voltmeters—reflecting—for low readings; a Paul Harris portable test-wire, a potentiometer outfit, standard resistances for laboratory work, and Nernst-Paul lamps and lanterns for demonstration purposes, will be shown by Mr. R. W. Paul. A Holden D'Arsonval galvanometer, electric pyrometers, resistance boxes, standard cells, and measuring instruments, by Messrs. James Pitkin and Co.; and Bastian mercury vapour lamps, the library being illuminated by means of these lamps. Lastly, Messrs. Carl Zeiss will have on view an optical appliance to facilitate visual perception of ultra microscopic particles; gold particles in colloidal solution will be shown with the apparatus; the particles are less in size than 10 $\mu\mu$.

RAILWAY MATTERS.

LATEST returns relating to the output of coal in this country show that the railways alone consumed 11,445,364 tons in 1904.

IT is understood that the Waterloo and Baker-street Electric Railway will probably be open for traffic early in the spring.

THE Pennsylvania Railroad is considering the advisability of operating its road between Camden and Atlantic City, N.J., by electricity.

THE South African railway revenue for the first ten months of 1905 was £3,342,000, and the expenditure £2,589,000. It is expected that by June 30th, 1906, the Colony will have paid off the redemption charges and the interest on capital.

THE German Federal Council have approved an expenditure of £252,500 for the construction of a new railway in German East Africa, from Luderitz Bay (Angra Pequena) to Kubub. The length of the new railway will be 93 miles, and the total cost is estimated at £475,000.

THE directors of the Erie Railroad Company have decided by a unanimous vote to re-sell the Cincinnati, Hamilton, and Dayton Railroad to Mr. J. P. Morgan in accordance with his offer. The reason assigned for the decision was that the retention of the line might involve obligations interfering with the development of the Erie Railway.

THE longest through trolley line in New England was opened recently from Boston to Fall River, Mass., without change, a distance of 53 miles. This through line has been considered for some time, in order to connect with the New York boats in Fall River, and its installation is being favourably received. The initial trip was made in three hours and twenty minutes.

THE growth and development of the Great Central Railway has at length reached the point when the company's works at Gorton are no longer capable of dealing efficiently with the upkeep of the rolling stock. A plot of land of 29½ acres between Guide Bridge and Hyde Junction was secured some time ago, and extensive carriage and wagon shops are being erected upon it.

A NEW railway is proposed from the High Peak of Buxton through Matlock, to Clay Cross, Heath, and Bolsover, thus opening up direct communication with a hitherto untapped area of the Derbyshire coalfield. The works would include a viaduct over Matlock Valley and the boring of a tunnel, a mile in length, near Tansley. The cost of the line is estimated at £900,000.

ON November 30th Sir W. F. Hely-Hutchinson opened the Cape Town to Sea Point Railway, a portion of the cost of which has been guaranteed by the residents of Sea Point. At the luncheon Dr. Smartt, Commissioner of Public Works, stated that it was proposed to introduce a railway guarantee Bill by which opportunities would be furnished for constructing branch lines similar to the Sea Point Railway.

THE construction of the underground railway from north to south in Berlin has, according to the *Norddeutsche Allgemeine Zeitung*, been finally approved by the municipal authorities. The line will start at Kreuzberg, in the street of the same name, and will terminate at the Seestrasse. The total length of the line is about 5½ miles, and there will be fourteen stations, at an average distance apart of 675 yards. The entire cost of this section is set down at £2,550,000.

THE Glasgow and South-Western has greatly improved its train service in Ayrshire by means of new rail steam motor cars, particularly between Ardrossan, Kilmarnock, and Ayr. No fewer than nine extra runs each way daily will thus be made between Ardrossan, intermediate stations, and Kilwinning, and two additional runs each way between Ardrossan and Largs. The motor carriages to be used are of the type built at Kilmarnock from the designs of Mr. Manson, locomotive, carriage, and wagon superintendent.

A KHEDIVIAL decree promulgated recently alters the constitution of the Egyptian State Railways, and the International Board has come to an end. In its place a general manager will have executive authority over the railways. To control his administration a Railway Board is created, consisting of three members *ex officio*—the Prime Minister, who *ex officio* will be president, and the Adviser to the Ministry of Public Works and Financial Adviser, together with such other members as the Council of Ministers shall designate.

THE London and South-Western Railway Company is about to open a line of 4½ miles connecting Bentley and Bordon, two Hampshire villages. Forming a junction on the Alton side of Bentley Station, the new railway runs through the parish of Binsted, and, passing near Kinsley, terminates quite close to Woolmer Forest, which, with the adjoining Alice Holt Forest, covers 10,000 acres. The land has been Crown property, and it will now become an important camp. In these circumstances the line will be used almost exclusively for military purposes.

IN a run made by a special train from Crestline, Ohio, to Clarke Junction, Ind., on October 24th, over the Pittsburg, Fort Wayne, and Chicago Railway, a speed of 74·55 miles an hour was made for 257·4 miles, which gives to the Pennsylvania lines decidedly the best record ever made for so great a distance, says the *Railroad Gazette*. The train which made this run was a special of four cars carrying a party of railroad officers to the Chicago meeting of the American Railway Association. The weight of the cars was 232 tons. The engine was one of the company's standard Atlantic type, weighing 80 tons, and, with tender, 143 tons.

A PROJECT for tapping the Sirhowy Valley, and lessening the railway distance between the important and practically virgin Monmouthshire coalfield, will be brought before Parliament by the London and North-Western Railway Company. The scheme comprises the construction of three railways; one of these will run from the Sirhowy branch of the London and North-Western Railway at Nine Mile Point to Caerphilly, where it will effect a junction with the Rhymney Railway; the second will be a continuation of this proposed railway to Penrhos Lower Junction, where it will effect a junction with the Barry Railway, and the third is called the Sirhowy loop, and joins at both ends the existing Sirhowy railway, but serves the eastern side of the valley, where the new coalpits are being sunk. The length of the railways approximately will be between 13 and 14 miles.

THE main direct line of the Canadian Northern Railway, extending north-westerly from Winnipeg, has, in the last few days, reached Edmonton, the capital of the new province of Alberta, the distance between the two cities being 830 miles, says a correspondent of the *Times*. Every mile of the way is through rich farming land, much of which is rapidly coming under cultivation for wheat, testimony to which is afforded by the elevators—these milestones of progress—that are springing up all along the line. The Canadian Northern main line traverses the Saskatchewan Valley, admittedly the richest wheat area in the Canadian North-West, excepting only the limited southern wheat belt of Manitoba. The time taken by special train for the 830 miles between Winnipeg and Edmonton is twenty-eight hours—a remarkable performance over a new railway, testifying to the excellence of the road bed and track. Between Battleford and Edmonton, over the most recently constructed portion of the line, a distance of about 250 miles, the time allowed to the special is nine hours.

NOTES AND MEMORANDA.

THE most powerful gun in the world has just been completed at Essen. It is a 16in. breech-loader of the built-up type, and the forgings for the tube and jacket are reported to weigh 184 tons. The tube is 49½ft. long.

ONE reason for the adulteration of graphite with coke dust or ground anthracite is found in the difficulty of detection. As the adulterants are nearly pure carbon, their use is not apt to be discovered without the most searching investigation.

OVER 15,000,000 tons of coal are annually brought into London. Of this amount rather more than one-half is brought by coasting steamers. The amount of coal used does not increase—a fact that is probably due to the increasing use of gas stoves.

IN Birmingham both the Corporation Gas and Electric Lighting Committees have reduced the price of their commodities for power purposes recently. Gas is now only 1s. 6d. per 1000, and electricity for power purposes up to 300 units, 2d. per unit, and over this amount, 1½d. per unit.

THE Hamburg astronomer, O. Steffens, has collected information which shows that of every million buildings in North Germany, 350 are struck per year by lightning. In South Germany the number is only half as large, possibly because there are fewer high factory chimneys, and more mountain peaks.

THE new triple-screw turbine steamer Carmania left Queenstown on Sunday morning for New York on her maiden voyage, having on board 1182 passengers. During the run from Liverpool in rather disagreeable weather, her turbines worked with smoothness and regularity, and afforded complete satisfaction.

IN New Zealand gasworks producing 2,000,000 to 3,000,000 cubic feet annually average 10,500 cubic feet per ton of coal carbonised, without an exhauster. The excellent bituminous coal found here contributes largely to the good results obtained. Nothing below 12,000 cubic feet per ton is considered a satisfactory yield in any well-equipped works.

OFFICIAL statistics — those of the Indirect Taxes Administration—show that there are in France 17,107 automobiles, comprising 12,713 with more than two seats and 4394 with one or two seats, against 1,637,562 vehicles—1,230,203 with two and 377,359 with four wheels—drawn by horses and mules. A tax is also levied on 16,118 motor cycles and 1,133,981 bicycles.

A MIXTURE of one part of coal gas to twelve parts of air will produce in the gas engine a temperature of explosion of 1000 deg. Cent., while the ordinary mixture used in these motors gives a temperature between 1500 deg. Cent. and 2000 deg. Cent. With the latter temperature, Mr. Dugald Clerk estimates that a first-class modern gas engine of about 50 brake horse-power would give an indicated efficiency of about 35 per cent.

TESTS of coals and lignites are being made by the United States Geological Survey, and are expected to give sufficient data to enable this material to be used to better advantage. Gas-producer tests, consuming about 10,000 lb., will be conducted for periods of thirty hours each. Tests already made have shown a development of 150 per cent. more power, when the coal is used in this form, than when used under a boiler in the ordinary manner. The Texas and North Dakota lignites show up well in these tests.

THE prize for a design of a Russian battleship, in a competition opened early in the year by the Imperial Russian Technical Society, has been awarded to Naval Engineer Achenbach, according to the *Kronstadtski Viestnik*. His design is for a battleship of 13,000 tons with turbines, and armed with ten 12in. guns disposed so as to be capable of being fired broadside to the number of eight, and fore and aft to the number of four. The armament is also to include twenty 4·7in. guns. It does not appear that the design has been, or is to be, acted upon.

AN alloy of two parts of aluminium and one part of zinc is equal, it is said, to good cast iron in strength, and superior to it in elastic limit. Its colour is white. It takes a fine, smooth finish, and does not readily oxidise. It melts at a dull red heat, or at a heat very slightly below, and is very fluid, running freely to the extremities of the mould, and filling perfectly small or thin parts; in that respect it is said to be superior to brass; but it is brittle, and hence unsuited to pieces which require the toughness possessed by brass. The tensile strength of the alloy is approximately 22,000lb. per square inch, and its specific gravity 3·3.

FROM returns just issued it appears that Great Britain has increased her output of coal by nearly 5 million tons during the last three years, whereas her greatest rival, the United States, has dropped 5 million tons since the last year of the returns. But, according to the Board of Trade report, she is still a bad second in the coal production of the world, being beaten by more than 80 million tons by the United States. Germany, which is third on the list, is creeping nearer, and the figures of the three countries for the recorded year are:—United States, 314,563,000 tons; Great Britain, 232,428,000 tons; and Germany, 120,816,000 tons.

ALTHOUGH the details of the big battleships and armoured cruisers now projected by Germany are still wrapt in mystery, there is no room for doubt that it is intended to build very big ships indeed. The size may approximately be inferred from the estimated cost. Battleships of the Braunschweig class displace about 13,000 tons, and have cost on an average 24,280,000 marks, or £1,214,000 per ship. The new ships will, it is estimated, cost 36,500,000 marks each—that is, half as much again as the older type. It is reasonable, therefore, to suppose that the size will be found to have increased in nearly the same ratio as the cost, in which case the tonnage of these new ships will be about 19,500. That is bigger than anything under construction or projected for any other navy, says the *Army and Navy Record*.

THE Russian cruiser Admiral Makaroff, which is being built by the Forges et Chantiers de la Mediterranée, at La Seyne, is so far advanced that she will be ready for launching next spring, says the *Kronstadtski Viestnik*. At the same yards has been recently finished the Russian torpedo-boat destroyer Iskusni. Her delivery trials at full 26-knot speed were considered quite satisfactory. Three others of the same type by the same builders have already completed their delivery trials. Four others are lying at Havre, where they have been built, and are now awaiting their trials. The length of each of these eight boats is 185·37ft.; beam, 21ft.; draught, 13·45ft.; armament, one 2·95in. and five 1·85in. guns, and two 17·7in. torpedo tubes. There are also four other Russian torpedo-boat destroyers built or building at Havre, of the French Framée type.

THE purification of the atmosphere from smoke has been delayed by the operation of hauling manufacturers into the police-courts of the country, says the *Chemical Trade Journal*. If offenders are to be summoned anywhere, let it be before some court understanding the subject—the repeated fining of manufacturers to no purpose, the absolute absence of help or sympathy in the matter from the administrators of the law, the failure by those in authority to appreciate what is possible and what is not possible, the acceptance of uncorroborated evidence from smoke inspectors, the partiality of many inspectors towards certain works, go to show that the smoke pollution of the country will not decrease until the matter is removed from the sphere of "local conditions," from the littleness of local administration-partiality, and-profit, and is taken in hand by a central Government department.

MISCELLANEA.

REUTER'S Stettin correspondent telegraphs that the new battleship Pommern, built for the German navy, was launched last Saturday at the Vulcan yard.

THE Machinery Committee of the Ipswich Guardians has under consideration the question of obtaining a new gas engine, altering the existing engine, and obtaining a gas producing plant.

THE Wellington, New Zealand, city engineer is having plans prepared for the new rubbish destructor to replace the now obsolete one at Clyde Quay. The ratepayers lately sanctioned a loan of £20,000 for this purpose.

THE immediate widening of Bull-street, Birmingham, near Martineau-street, has been agreed to. It is proposed to pave the carriage-way on either side of the tramways in various streets at a total estimated cost of £2660.

THE new harbour works at Famagusta, Cyprus, are now practically complete, the works including a large outer harbour, with 4½ to 7 fathoms of water, an approach channel, an inner harbour, 900ft. long, 600ft. wide, and 24ft. deep, and an additional basin at the southern end of the inner harbour, 450ft. long, 200ft. wide, and 15ft. deep.

AN inquiry will be held by Mr. H. Ross Hooper, on December 12th, into the application of the Brighton Town Council for power to borrow £38,500 for purposes of electric lighting, and £5909 for the purpose of acquiring the site of the Star Foundry in Bread-street and the erection thereon of buildings in connection with the electric light undertaking.

A PNEUMATIC tube of large diameter has been laid between the Luxembourg, the Palais Bourbon, and the offices of the *Journal Officiel*, Paris, for superseding the numerous estafettes, always liable to be interrupted in time of riot. In this manner also the reported speeches of senators and deputies can be sent to the *Officiel* printing office, and the proofs returned for correction.

PROGRESS is being made with the electric driving of cotton mills in Lancashire. During last week the Hope weaving shed at Burnley commenced to run under the new system, says a *Times* correspondent. Formerly the Hope weaving shed was driven by compound steam engines and Lancashire boilers. The electric driving of this shed is only part of a much larger scheme.

THE microphotoscope, invented by a Berlin chemist, though no larger than a cigar case, permits of consulting the map of a whole district by night as well as by day. The map is photographed in miniature on a plate of ground glass, which is illuminated by a small incandescent lamp supplied, when required, with current from a battery, while a lens can be adjusted to the observer's sight.

SEVERAL French inventors are working at a *lévocyclette*, or bicycle, in which levers are substituted for cranks; and Dr. Matthieu, of the French Touring Club, considers that the hill-climbing machine of the future will be one with practical combination of pedalling by direct propulsion, to permit of mounting the steepest gradient slowly, and a loose wheel, to permit of descending rapidly with the body at rest.

THE management of the Clyde Navigation Trust notify that from noon on 11th inst. an important change will be made in connection with the operations of rock blasting being carried on across the river at Elderslie. The south half of the river, which has been closed to navigation for a considerable time, through the presence of boring barges, dredger, and diving-bell, will, on that date, be open for navigation, and the north half will be closed until further notice.

THE Motor Union has ascertained that there were twenty appeals at the Michaelmas quarter sessions against convictions under the Motor Car Act. Eight were successful, eleven were unsuccessful, and one was adjourned. This high proportion of successful appeals is regarded as demonstrating the importance of the appeal provisions of the Motor Car Act. Since January 1st, 1904, 77 motor car appeals have been heard by quarter sessions. Of these 30 were successful, in seven cases the convictions were upheld but the penalties reduced, and 37 were unsuccessful. Of the three remaining cases one failed on a technical objection, one was abandoned, and one was adjourned.

AT the annual social gathering of the workmen of Argyll Motors, Limited, held in Glasgow last week, Mr. Alexander Govan, managing director of the company, said that his board were very desirous that as many as possible of the workmen—of which there will be at least 2000—should live near the new works of the company, now nearly complete, at Alexandria, in the Vale of Leven. He gave details of the plans devised by the directors for housing and providing healthy recreation for the workers. The inducements would be such as could not fail to attract many of them to leave the murky city and settle down in the healthier atmosphere in which the new works and houses were situated.

THE Hon. Charles Parsons, lecturing on Saturday night in the Armstrong College, Newcastle-on-Tyne, gave a history of the initiation and development of the steam turbine for land and marine purposes, and mentioned some facts that have not hitherto been made public. Dealing with the application of turbines to Atlantic passenger steamers, Mr. Parsons detailed the recent trials of the Cunarder Carmania, with turbine engines, and her sister ship, Caronia, with reciprocating engines, the latter being one of the most economical vessels ever built. The Carmania beat the Caronia by one knot, and was at least 16 per cent. more economical than her sister vessel driven by reciprocating engines. The Carmania was the first example on so large a scale, and it might be reasonably expected that improvements in detail would still further increase the excellent results she had realised.

IN presenting the prizes gained by the students of the Incorporated Weaving, Dyeing, and Printing College, Glasgow, last week, the Right Hon. the Lord Advocate, Mr. C. Scott Dickson, said that in the cotton, woollen, and silk industries this country had a large volume of trade left, supplying many markets, with keen competition, no doubt, but just because of that competition, if they were to keep the trade—and, still more, if they were to extend it—everyone concerned must see that the best possible work was carried out. There was nothing better calculated to secure that result than that young men should have such training as that college provided, one of its great benefits being that it stimulated experiments and prompted invention. An interesting exhibition of French textile art was opened at the college in the afternoon, principally for the use of the students of the Weaving College.

AT the meeting of the Glasgow Technical College Scientific Society, on the 25th ult., Mr. A. Marshall Downie, B.Sc., read a paper on "The Commercial Efficiency of Prime Movers." The idea of commercial efficiency, the lecturer said, was based on the two fundamental principles of economical conversion of energy and low first cost, and it would be shown how in the case of prime movers these two could be expressed in common terms and used as a basis of comparison, intelligible alike to the engineer and his client. By means of wall diagrams the author showed results obtained from representative test of the three principal types of prime movers, *i.e.*, reciprocating steam engines, steam turbines, and gas engines, and then compared the relative capital outlay and working expenses, &c., required in a power station of given output fitted with prime movers of each type. The lecture was illustrated throughout with lantern views, and a discussion followed.

THE CONSTRUCTION OF A GREAT CUNARD LINER

SWAN, HUNTER, AND WIGHAM RICHARDSON, LIMITED, WALLSEND-ON-TYNE, BUILDERS

(*For description see page 558*)

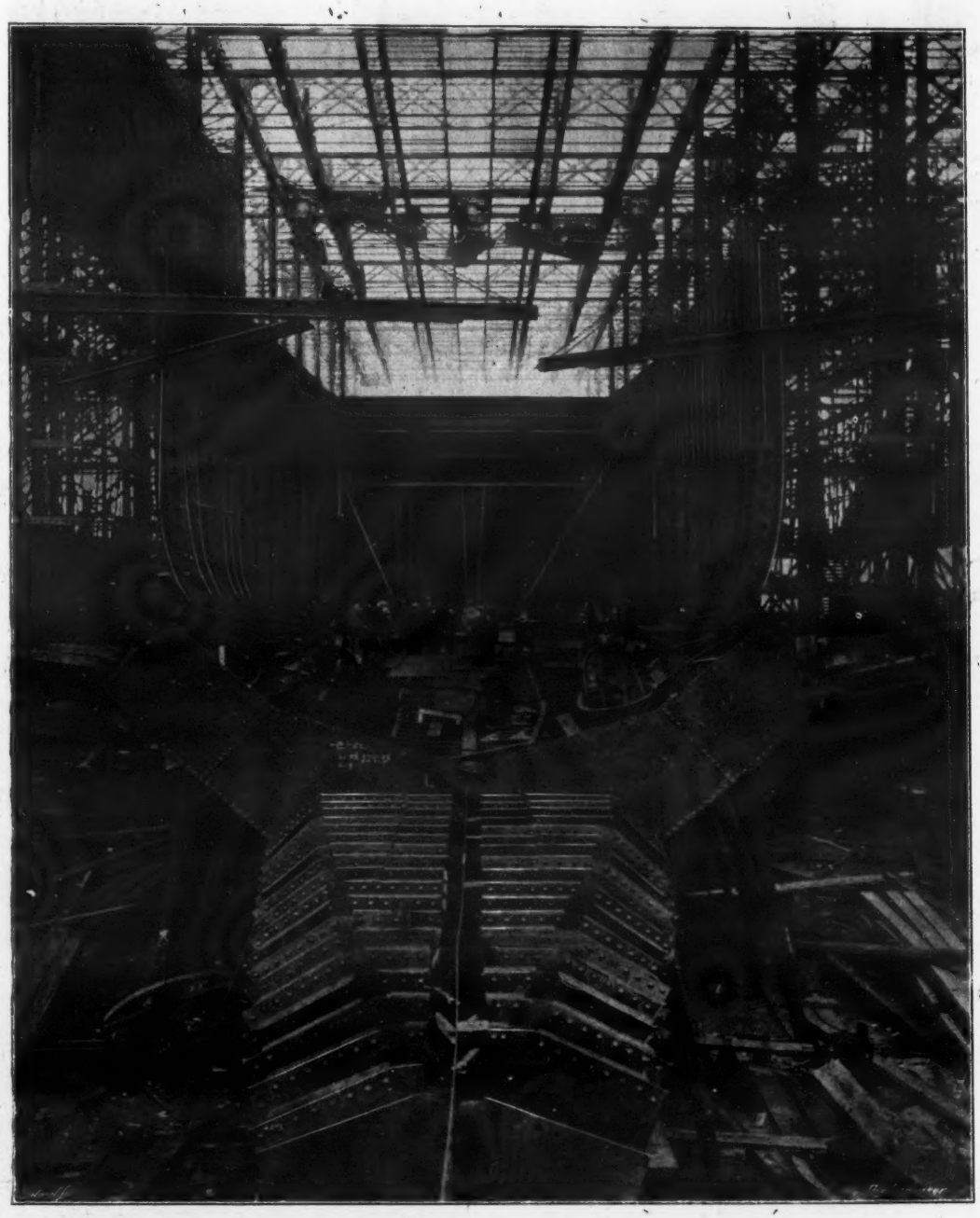


Fig. 5—FRAMES AND BEAMS IN POSITION UP TO ENGINE-ROOM

Fig. 6—FRAMES WITH BOSSING FOR PROPELLOR SHAFTS

THE CONSTRUCTION OF A

SWAN, HUNTER, AND WIGHAM RICHARDSON, LI

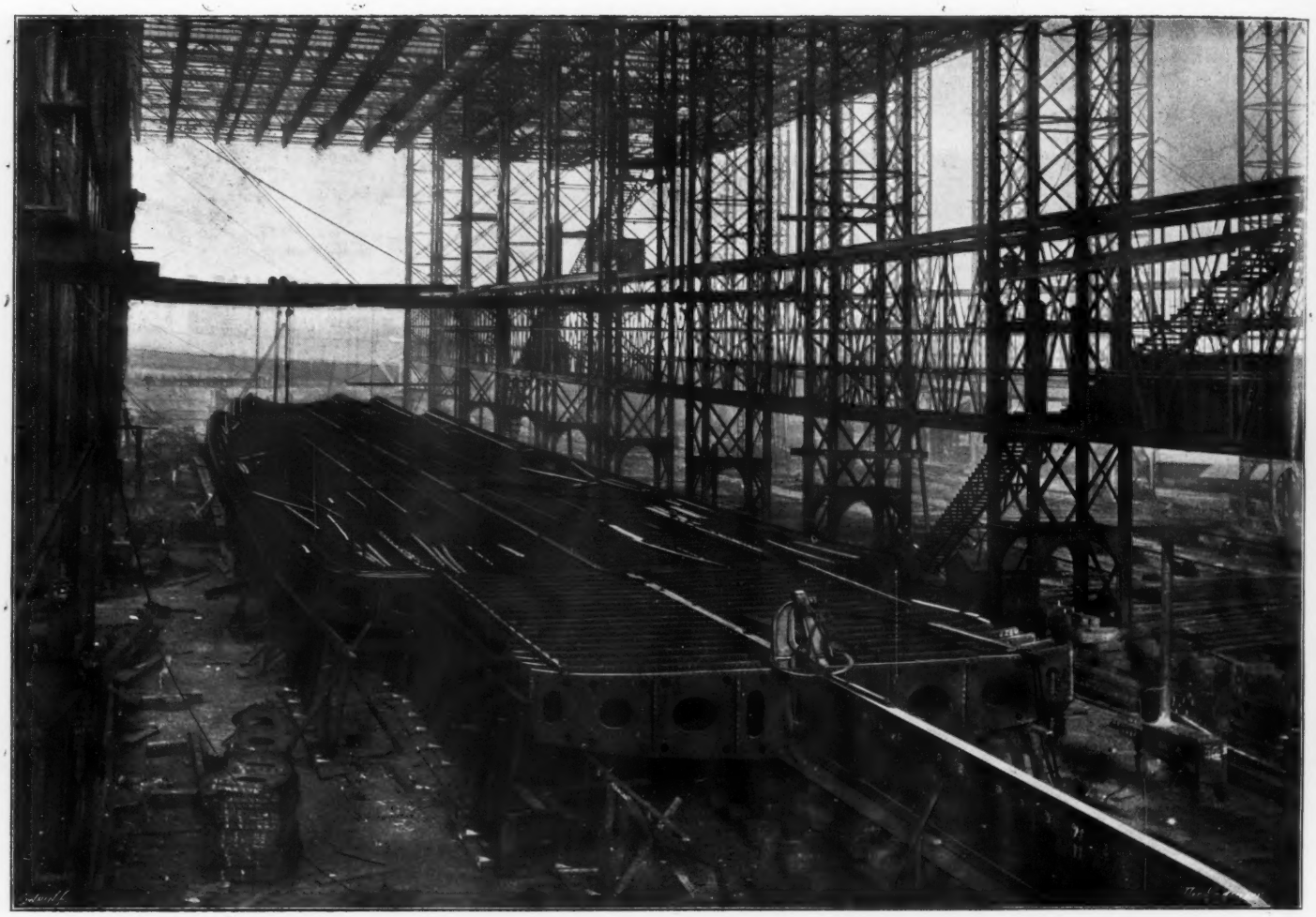


Fig. 1—MIDSHIP PORTION OF STRUCTURAL CELLULAR BOTTOM

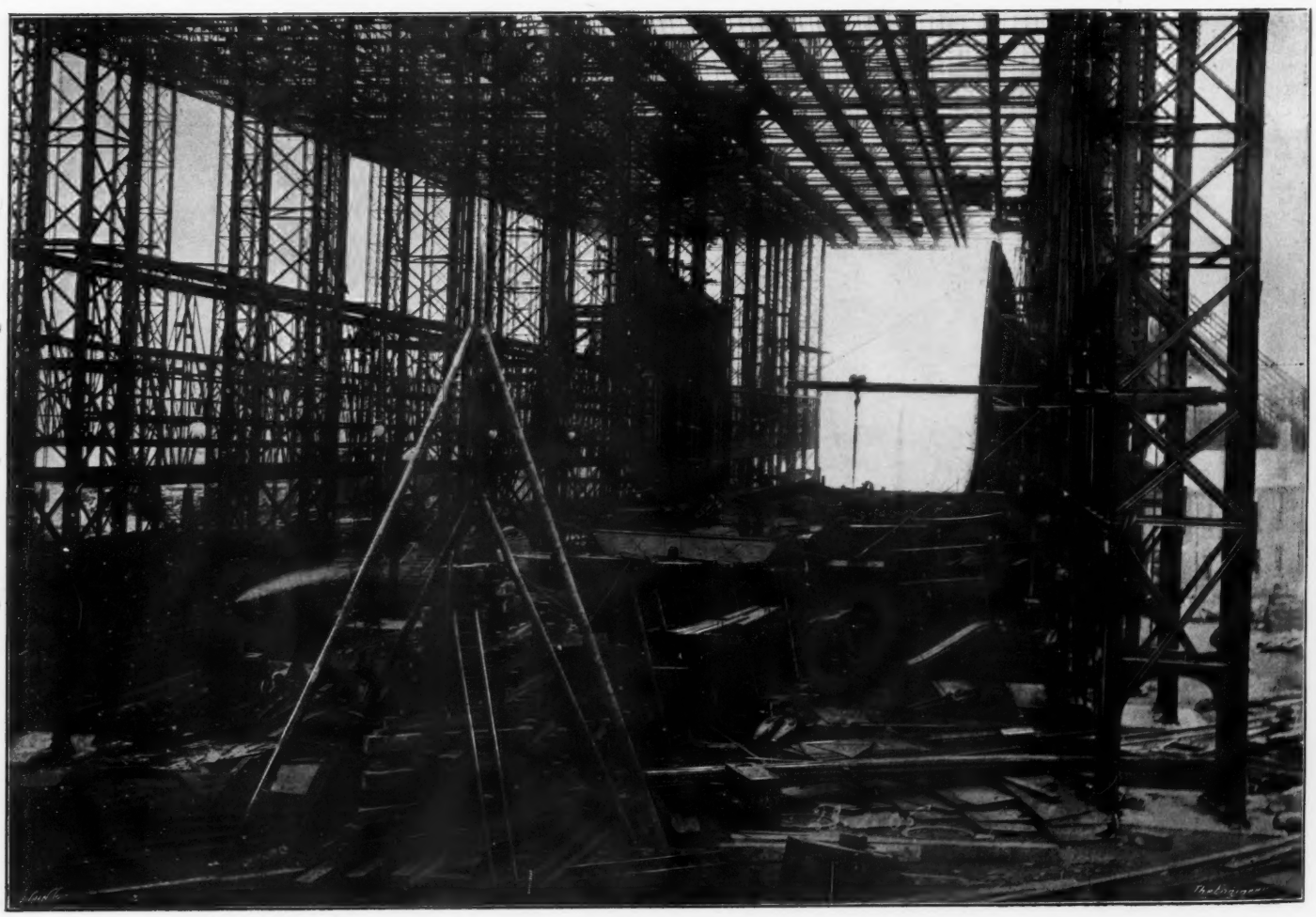


Fig. 2—DOUBLE BOTTOM AND SIDE FRAMING FROM FORE END

Fig. 3—FORWARD PORTION OF FRAMING ERECTED, AND INNER BOTTOM PARTLY PLATED

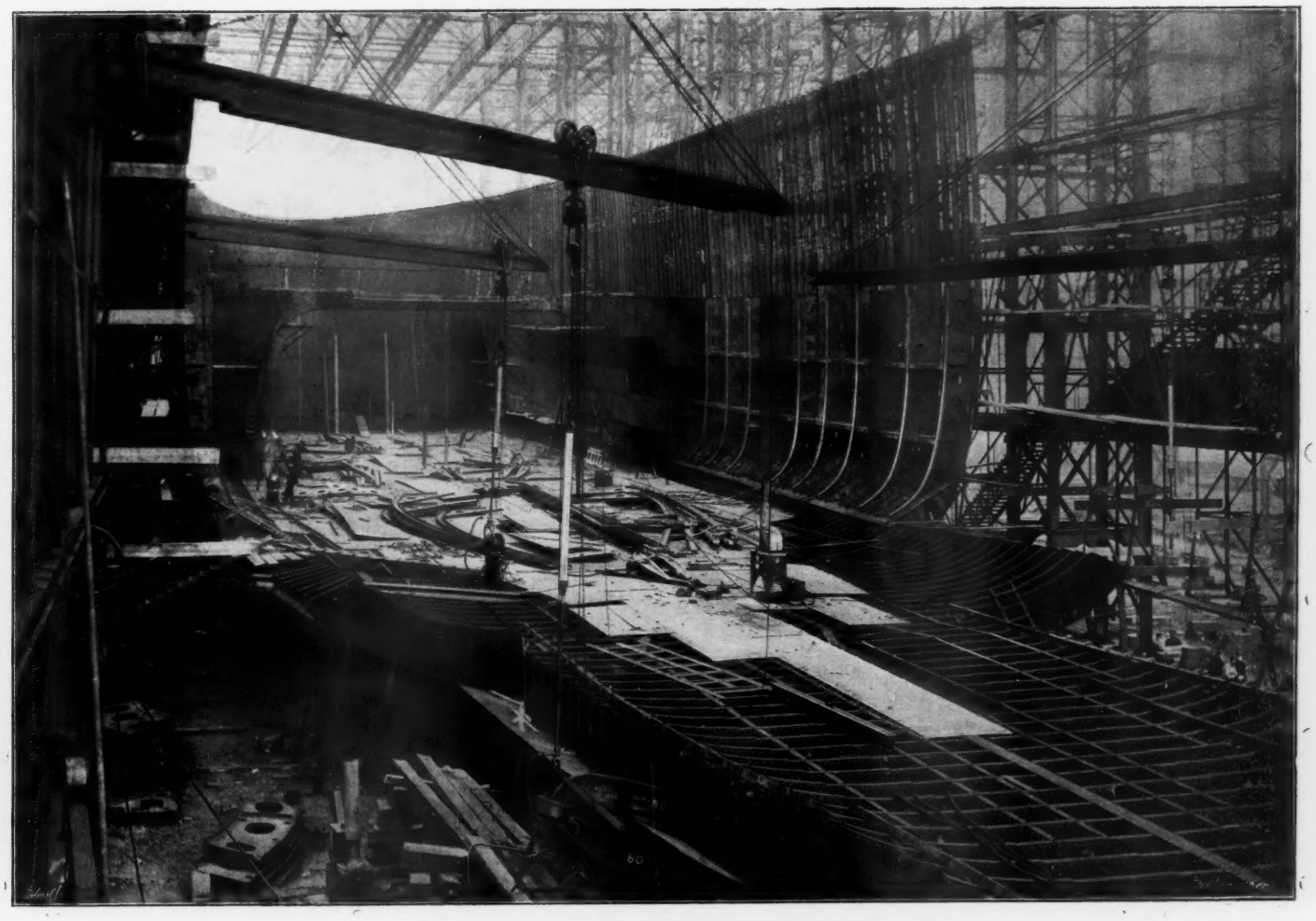


Fig. 4—FRAMING AT FORE END COMPLETED, AND BULKHEADS ERECTED

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Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening, and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Ten o'clock on Tuesday morning in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON." Telephone—No. 13352 Central.

PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Engraving of the Construction of a Great Cunard Liner. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

☞ *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

G. W. H.—We know of no benevolent society especially intended for engineers.

N. J. (Godley).—There is no formula connecting the data for fans you give. The delivery, and hence the pressure, depend on many things, and vary with different types and designs.

W. M. (Failsworth).—(1) Write to the Board of Trade, Marine Department, Whitehall. (2) You will find the rules and formulæ in several books on marine engineering; see Seaton's "Marine Engineering" (Chas. Griffin).

INQUIRIES.

METALLIC PACKING.

SIR,—Can any of your readers supply the address of the makers of "France" metallic packing? A. C. P.
December 4th.

MEETINGS NEXT WEEK.

THE RAILWAY CLUB.—Thursday, December 14th, at 7.30 p.m., at St. Bride's Institute, E.C. Annual general meeting.

INSTITUTE OF MARINE ENGINEERS.—Monday, December 11th, at 8 p.m., at 58, Romford-road, Stratford, E. Paper, "Some Experiences with CO_2 Cylinders," by Mr. R. Mackenzie.

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—Monday, December 11th. Paper, "Organisation in Small Engineering Works," by Mr. A. W. Waddy.

PHYSICAL SOCIETY OF LONDON.—Friday, December 15th, at 7 p.m., at the Royal College of Science, Exhibition-road, South Kensington. An Exhibition of Electrical, Optical, and other Physical Apparatus.

BRADFORD ENGINEERING SOCIETY.—Monday, December 11th, at 7.45 p.m., at the City of Bradford Technical College. Paper, "Lubrication," by Professor G. F. Charnock, Assoc. M. Inst. C.E., M.I. Mech. E.

THE ROYAL SCOTTISH SOCIETY OF ARTS.—Monday, December 11th, at 8 p.m., at 117, George-street, Edinburgh. Paper, "On Modern High-power Gas Lighting," by Henry O'Connor, Assoc. M. Inst. C.E., P. Pres. Soc. Eng.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.—Thursday, December 14th, at 3 p.m. Visit to Lots-road Power Station. At 8 p.m., at the Society of Arts. Paper, "On Improvements in Trucks," by Mr. Elmer E. Cook.

LIVERPOOL ENGINEERING SOCIETY.—Wednesday, December 13th, at 8 p.m., at the Royal Institution, Colquitt-street. Ordinary meeting. Paper, "The Use of Electric Power in Collieries," by Mr. P. Barrett Coulston, M.I.M.E.

THE ENGINEERING AND SCIENTIFIC ASSOCIATION OF IRELAND.—Monday, December 11th, at 7.45 p.m., at the Royal College of Science, Stephen's Green, Dublin. Ordinary general meeting. Paper, "The Law of Contracts," by Mr. A. P. Bynd, B.L.

THE INSTITUTION OF CIVIL ENGINEERS: ASSOCIATION OF YORKSHIRE STUDENTS.—Thursday, December 14th, at 8 p.m., in the Law Institute, Leeds. Ordinary meeting. Paper, "The Crowle Swing Bridge Viaduct," by Mr. J. Alexander, Assoc. M. Inst. C.E.

CLEVELAND INSTITUTION OF ENGINEERS.—Monday, December 11th, at 7.30 p.m., in the Hall of the Cleveland Literary and Philosophical Society, Corporation-road, Middlesbrough. Paper, "Design, and the Safety of Machinery," by Mr. Edward Crowe, of Stockton.

INSTITUTION OF ELECTRICAL ENGINEERS: BIRMINGHAM LOCAL SECTION.—Wednesday, December 13th, at 7.30 p.m., in the Large Lecture Theatre, the University, Edmund-street. Ordinary general meeting. Paper, "Two New Electricity Meters," by Mr. S. H. Holden.

THE INSTITUTION OF ELECTRICAL ENGINEERS: GLASGOW SECTION.—Tuesday, December 12th, at 8 p.m., in the Large Lecture Hall, 207, Bath-street, Glasgow. Ordinary general meeting. Paper, "Recent Advances in Wireless Telegraphy," by Mr. J. Erskine-Murray, D.Sc.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 14th, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster, S.W. Ordinary general meeting. Adjourned discussion on paper, "The Charing Cross Company's City of London Works," by Mr. W. H. Patchell, Vice-president.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 12th, at 8 p.m. Ordinary meeting. Discussion on paper, "The Steam Turbine," by the Hon. Charles Algernon Parsons, C.B., LL.D., F.R.S., and George Gerald Stoney, MM. Inst. C.E. Friday, December 15th, at 8 p.m. Students' meeting. Paper, "Tests of Street Illumination in Westminster," by E. E. Mann, B.Sc., Stud. Inst. C.E.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, December 15th, at 8 p.m., at the Institution House, Storey's-gate, St. James's Park. Ordinary general meeting. "The Seventh Report to the Alloys Research Committee: On the Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys," by Dr. H. C. H. Carpenter, Mr. R. A. Hadfield, and Mr. Percy Longmuir. Paper, "Behaviour of Materials of Construction under Pure Shear," by Mr. E. G. Izod.

SOCIETY OF ARTS.—Monday, December 11th, at 8 p.m., at John-street, Adelphi, W.C. Cantor Lectures: "The Measurement of High-frequency Currents and Electric Waves," by J. A. Fleming, D.Sc., F.R.S. (Lecture III.) Tuesday, December 12th, at 8 p.m. Applied Art Section. Paper, "Historical Pageants," by Louis N. Parker, F.R.A.M. Wednesday, December 13th, at 8 p.m. Ordinary meeting. Paper, "The Commerce and Industries of Japan," by W. F. Mitchell. Thursday, December 14th, at 4.30 p.m. Colonial Section. Paper, "Glimpses of French Canada," by the Hon. Rodolphe Lemieux, K.C., Solicitor-General of Canada.

THE ENGINEER.

DECEMBER 8, 1905.

ADMIRALTY POLICY.

ELSEWHERE we give extracts from a Blue-book, entitled "A Statement of Admiralty Policy," which has just been issued. It is not remarkable that we have nothing but praise for this policy, seeing that it recognises to the fullest extent principles for which we have long contended, and methods which we have constantly asserted had become essential to the maintenance of the efficiency of our Fleets. The Blue-book sets forth for popular consumption, in excellent English, with the utmost lucidity, the scheme which the Admiralty have proposed for the management of the British Navy in all its details. With much of this THE ENGINEER is only indirectly concerned—as, for example, the relative strength of squadrons and the distribution of warships; but more than enough remains for consideration at our hands.

For the first time publicly and without any reservation the Admiralty admits that the modern fighting ship has little or nothing in common with the man-o'-war of Nelson's day. Sails and masts and rigging have entirely disappeared. We have enormously costly floating machines, which are, indeed, only ships because they float and move through the water. The "sailor" has gone, and his place is taken by the engineer. The world has been familiar for years with struggles and wrangles and disputes about the rank, pay, and precedence of the naval engineer. The new Admiralty policy settles all these questions at one stroke. There is no longer any such thing as a Naval Engineer in the old sense of the word; instead, every officer in a ship will be an engineer. We long since maintained that there was no reason why an engineer should not command a ship or become an admiral. The Admiralty contemplates such events with more than equanimity. Under the new system of training all will study every branch—engine-room, gunnery, torpedoes, navigation. Not until the rank of sub-lieutenant has been reached will specialisation in any particular branch be permitted. In other words, it has been decided that all executive, engineering, and marine duties will be performed by executive officers of common entry and training, who will specialise for the different duties without separating into permanent and distinct branches. A few words of explanation may be useful here. Boys enter the training colleges at Osborne and Dartmouth at an early age, and all study together and learn the same subjects. After four years shore training, when they are sixteen or seventeen years old, they will be sent to sea as midshipmen for about seven months. Then they will be divided into groups of about a dozen, and sent to serve on board some newly commissioned ship. They will be divided into sections; one section will work below in the engine-room, another on deck with the commander, another with the gunnery lieutenant, and so on. The period of instruction at sea will be three years. They will then pass examinations and become acting sub-lieutenants. Further training on shore then takes place; and, finally, those who desire to take advanced courses in particular branches specialise so far. But it will be seen that although a man becomes a gunnery lieutenant, and possesses a particular knowledge of gunnery, he is none the less fitted to take charge in an engine-room; while, on the other hand, a specialised engineer must be also a competent gunnery officer. Specialisation, in point of fact, means something more than mere competence. All must be competent to discharge every branch of the duties of a naval officer; but the specialist will be much more than competent in his own particular line. We cannot form a concept of any system better calculated to promote efficiency, good fellowship and an admirable rivalry; and it will be seen that under these conditions the chances of promotion are not limited to one branch of the service. The engine-room is just as likely to provide the nation with admirals in the future as is the deck.

We turn now to a matter of very great importance, namely, "engine driving." We have always maintained that men highly trained in mathematics, thermodynamics, and science generally, were not only not wanted in an engine-room, but their very training unfitted them for the drudgery of watch-keeping. This truth the Admiralty have at last recognised, and what is to all intents and purposes a new class of engine-room watch-keeper is to be established. Artificers who have served a long apprenticeship, and are exceptionally skilful workmen, will no longer drive engines; and in their stead engine-room watch-keeping will devolve on the stokers. Picked men will undergo a special training, and ultimately become "mechanicians." The mechanician will become the watch-keeping petty officer, and will have seniority of command over other chief stokers not so rated. After a sufficient period of training at sea, these men will become eligible for the rank of warrant officers. Here is an enormous change in the attitude of the Admiralty. At last it has come to be understood that engine driving is one thing, engineering science quite another. We shall still have on board ship the brain to direct, in the shape of the engineer officers; and in the engine-room the hands to work. In the past it has been held that the engineer should combine hands and brains in his own person. We have now, furthermore, the skilled workman left free to carry out repairs all over the machinery of the ship. Nothing, we think, but good can come of such a system.

Something remains to be said concerning the management of the dockyards and shipbuilding establishments generally, but we must reserve this

subject for future consideration; we have done little more than direct attention to a few salient points in a great policy.

STANDARD LOCOMOTIVES FOR INDIAN RAILWAYS.

The second issue of the report of The Locomotive Committee on Standard Locomotives for Indian Railways, published by the Engineering Standards Committee, lies before us. It is a very simple, straightforward document, but none the less does it stand for a great experiment. It remains to be seen how far five types of locomotives, and five only, can be made to satisfy the traffic demands of a country so enormous as India. It has been said over and over again that the multiplication of types of railway engines is a great mistake. There is much truth in the argument. If the conditions of the report before us are adhered to, there will be in future in India five types only, which are supposed to be sufficient to satisfy all main line requirements. It is suggestive that the first issue of this report was made in November, 1903. Since its publication the first standard engines have been actually built, and, in the light of the experience obtained from them, certain revisions have been found necessary in the report. The present issue embodies the necessary alterations. What these are is not set forth. They refer, we may say, however, only to matters of detail.

The value of a report of this kind depends entirely on the special competence of the men making it. It is worth notice that of the twenty-nine names of the members of the Committee on Locomotives only seven are locomotive specialists, and of these, unfortunately, Mr. Dean is dead and Mr. Webb was too ill to take any part in the proceedings. The Locomotive Conference, however, formulated the standard conditions. We give the names of its members:—Messrs. F. E. Robertson, C.I.E., Chairman, Rendel and Robertson; J. M. Dobson, Hawkshaw and Dobson; Bradford Leslie, A. J. Barry and Leslie; S. B. Tritton, Rendel and Robertson; R. White, Sir G. B. Bruce and White; H. C. Arbuthnott, Taylor Brothers and Co.; W. Collingwood, Vulcan Foundry, Limited; G. Dawson, Beyer, Peacock and Co., Limited; E. Greg, Nasmyth, Wilson and Co., Limited; N. Norman, R. Stephenson and Co., Limited; T. P. Reay, Kitson and Co., Limited; J. F. Robinson, North British Locomotive Co., Limited. By request, we do not reproduce any portion of the report, but we can set forth its principal features. There are two gauges only dealt with—the 5ft. 6in. and the metre gauge. The first gives the designer almost unlimited opportunities, and as bearing strong testimony to what we said last week about modern developments of the locomotive, we find that the compound system in every shape has been ignored. The standard passenger engine has a leading four-wheeled bogie, and four-coupled wheels 6ft. 2in. diameter; two inside cylinders, 18½in. by 26in., 180 lb. pressure, 1349·5 square feet of heating surface, 25 square feet of grate; total weight in working order, 51 tons. The tender is supported on six wheels, and carries 7½ tons of coal and 3000 gallons of water; weight full, 39½ tons. The standard goods engine has the same boiler, and cylinders, and tender. The principal difference is that it has no bogie, and is carried on six coupled wheels, 5ft. 1½in. diameter. The engine weighs 48 tons. The total weight with the tender is 87·5 tons. The metre gauge engine has outside cylinders 15½in. by 22in., six coupled wheels 4ft. 9in. diameter, and a leading bogie. The pressure is 180 lb.; heating surface, 1062 square feet; grate area, 16 square feet. The tender carries 4 tons of coal and 2000 gallons of water. The engine weighs 33·7 tons; the tender, 22·75 tons. The mixed traffic metre gauge engine has the same boiler, cylinders, and pressure, but it is carried on six coupled wheels 4ft. diameter, and a four-wheeled leading bogie. The weights are nearly the same as those just given. The fifth type is a "Mastodon" goods or mineral engine, metre gauge; pressure, 180 lb.; the boiler has 1291 square feet of surface, and 17·5 square feet of grate; cylinders, 16in. by 22in. There are eight coupled wheels, 3ft. 7in. diameter, and a four-wheeled bogie. The engine weighs 39·5 tons, and the tender, with 4 tons of coal and 2000 gallons of water, 23 tons. Outline elevations are given of all the engines and tenders, and they favourably impress us. They are handsome locomotives, and seem to be well calculated to do their work.

There are, we think, certain points open to criticism. It would, indeed, be impossible to design a locomotive that would please every one; but, on the other hand, there are some excellent features. Thus, the staying of the fire-box sides appears to be very good. Nothing less than 1in. diameter, screwed twelve threads to the inch, and not spaced more than 4in. apart. Belpaire boxes are adopted. Nothing, however, is said as to the width of the water space. With the 5ft. 6in. gauge nothing less than 3⅜in. clear should be permitted. A minimum bridge of ¾in. between the holes in the copper tube plate is to be preserved, and the tubes are not to be less than ⅝in. apart. One inch between the holes in the tube plate and ¾in. between the tubes would have made a better boiler. As only dimensions are given, no stipulations are laid down as to the treatment of the copper tube plate. Great advantages are claimed in France for the system of planishing it down in thickness from 1⅛in. to 1in., so rendering it harder and reducing tube-end leakage. We might take the various stipulations step by step, but, on the whole, they represent excellent practice, and will, no doubt, be found in the main very satisfactory indeed. To a considerable extent the locomotives of the G.I.P. lines have been copied; but the best features of all the other main line engines have been utilised. The policy of the Conference is set forth in the following passage. It may be taken, indeed, as the keynote of the harmony which, it is to be noted, is about to be secured:—"The wheel diameters were fixed with the view of using tires identical with those of the largest number of engines of this type existing in India; certain details, such as the type of brake, smoke-box, and the style and position of the reversing gear, not being essential parts of the design, were left to be settled as may be found desirable in each particular case. Taking next the goods engine for 5ft. 6in. gauge lines, as arranged by the Conference, the boiler, cylinders, valve motion, axles, axle-boxes, horn-blocks, &c., are as far as possible identical with corresponding parts of the passenger engine design, while the wheel diameter has been fixed to enable the tires to duplicate with those of the largest number of engines of this type existing in India."

It is a noteworthy feature of the report that no sanction whatever has been given to modern inventions. Thus the extended smoke-box has been ignored. No reference is made to superheating or heating the feed water. The now old-fashioned "four slide bars to each cylinder" is retained. The link motion is to be of the Stephenson type. Nothing is said about the valves, but the arrangement of the cylinders is such that piston valves could not be used. For the metre gauge engines, balanced valves driven by Walschaert gear are to be employed. We have in point of fact five well approved types of engine, in which we seek in vain for evidence of recent development; but, on the other hand, the designs are, we think, certain to give satisfaction, and it must not be forgotten that the Committee do not put their designs forward as representing only those locomotives which shall be built in future. On the contrary, they say explicitly:—"These designs, especially as regards the 5ft. 6in. gauge, only provide for passenger and goods engines and tenders of the type which it is thought will prove most universally useful at the present time on the majority of Indian railways; but the Committee wish it to be understood that they consider that other types, for heavy passenger and goods work, and for ghâts and shunting purposes, will have to be designed on the same lines to fulfil the requirements of the various railways in India as they may arise." It remains to be seen how far the standard engine will be adopted in future. An enormous advantage would be obtained if it was fully understood that at all events for some years, orders for no others would be given out. Makers could then build for stock with safety. What that means we need not waste space by pointing out.

SYNDICATES IN GERMANY.

The investigation into the working of the numerous industrial syndicates in Germany, to which reference was last made in these columns in September of 1904, has now been completed, and a report on the subject has just been presented to the Imperial Parliament by Count Posadowsky. British firms are so largely interested in the operations or competition of Teutonic syndicates in the markets of the world, whether they are concerned with the coal trade, the iron and steel industry in all its branches, or the chemical trade, that it is scarcely essential to dwell upon the importance of the question in these days of increasing business combinations. By way of premise it is necessary to recall the fact that the German Government inquiry, which has extended over a period of two years, has not taken the form of an investigation such as would be understood from a parliamentary inquiry in the United Kingdom. The information obtained in the Fatherland has partly been secured by means of the issue of a circular in the form of questions, and partly by the holding of conferences which are termed "contradictory proceedings," and presided over by a Government official, with closed doors. No power was conferred upon the president to ask compulsory questions of the representatives of the syndicates and of the consumers who attended the conferences, nor were either of the two opposing interests placed under any obligation to answer questions. On the one hand the consumers made their charges against the combinations in regard to preferential treatment of foreign purchasers, and made other allegations, whilst on the other the representatives of the syndicates sought to refute the accusations. It was as optional for the presiding official to ask questions as it was optional for the representatives of either side to answer them. The conferences consequently fully justified the appellation of contradictory proceedings, and the value of the official reports which were occasionally issued was prejudiced by the fact that they were edited, and, by previous arrangement, every statement was omitted which in the opinion of either the syndicates or the consumers might detrimentally affect their interests.

It is on the above unsatisfactory basis that the report of the syndicate inquiry has been founded, but the document must be taken for what it is worth. It reveals in the first place the existence of three hundred and eighty-five syndicates in Germany, although it is believed that the actual number is larger. The principal syndicates are represented by the coal industry, which is recorded as possessing nineteen; the iron and steel industry has sixty-two combinations, which obviously include the engineering trades; the chemical trade has forty-six, the electrical branch is credited with two, and the hardware industry with eleven syndicates; while the remainder relates to the textile, glass, brick, stone, and other manufacturing trades which need not be specifically mentioned. The report states that the majority of the syndicates readily imparted information bearing upon the question, and in particular the steelworks syndicate, the coal syndicate, and other large combinations. Nevertheless, a far-reaching endeavour was manifested to withhold information, even as to the very existence of syndicates. Indeed, twenty organisations entirely failed to reply to the circular questions, notwithstanding repeated warnings, while fifty others either expressly declined or kept silent in regard to the interrogations placed before them. It was also impossible to gain any information where international agreements are in operation, or where large firms have established communities of interests with others engaged in the same or similar branches. The majority of the syndicates have been constituted since 1880, and the highest point was reached in the years 1903 and 1904, while the number of industrial establishments comprised in the syndicates referred to exceeds twelve thousand, of which the first position is occupied by the coal, iron, and steel, engineering and chemical industries.

The large amount of information contained in Count Posadowsky's report is interesting from a statistical point of view, but it is of little value from a practical standpoint. All the syndicates are dependent for their existence upon the operation of high import duties, which allow the trades concerned to charge inland consumers high prices, which are regulated by the quotations of foreign competitors plus cost of carriage and payment of duties, while the surplus production available is exported at prices which will just undersell the native firms in the country to which the exports are consigned. It was precisely these accusations of preferential treatment by the syndicates of buyers in other countries that led to the agitation in Parliament for the institution of an inquiry into the whole question, but what has been the result? We certainly cannot blame the German Imperial Government for the absence of positive conclusions, because, according to the present situation of legislation, the communication of information is entirely voluntary. We were not previously aware that it was impossible for the Imperial authorities to appoint a committee and send for witnesses to give evidence on oath, but we must conclude that this is the case, as Count Posadowsky states that there is no compulsion under the existing law. It also appears obvious from the report that if the syndicates have not voluntarily given all the information which the Imperial Home-office authorities deem to be necessary to throw light on the origin, organisation, and activity of the combinations, the Government may seek powers to ascertain such particulars, which means the initiation of legislation for the control of syndicates, as has been threatened for over a year. It is, however, to be feared that if this object was ever seriously in view, it is likely to be counteracted, if it has not already been checked, by the amalgamations, consolidations, and community of interests which have been brought about in the

past two years in the coal, iron, and steel, and chemical industries in different parts of the country. The large individual undertakings in these branches have become still larger, and they have been transformed in many cases into such self-contained units that syndicate legislation would not affect them, and would not relieve their inland consumers. Neither would any such legislation, and it has yet to be decided whether it is possible or necessary, bring about any change in the competition offered by German firms, either syndicated or uncombined, in the English market and the markets of the world. If the Teutonic inland consumers had any hope of relief from legislation, there would be some hope of other countries being correspondingly assisted, but it is entirely out of the question for the German Government to do anything to check the export trade.

THE WITHAM ACCIDENT.

THE result of the Board of Trade inquiry carried out by Colonel Von Donop, R.E., into the circumstances of the derailment at Witham Station, which occurred on the 1st September about 10.30 a.m., has just been made public. It will be remembered that a Great Eastern down train consisting of an engine, tender, and fourteen vehicles ran off the road when passing through Witham Station at high speed. Two of the coaches mounted the down platform and killed a porter. One was quite overturned, and smashed up. The wheels and underframing fell on and crushed the passengers. The details of the catastrophe need not be reproduced here. The question of paramount interest is, Why did derailment take place? This is a question which is very frequently difficult to answer; sometimes no answer is ever found. The Witham accident is no exception to the general rule. No certainty exists as to the cause, and Col. Von Donop, after weighing the evidence, can at best only assign an explanation which without being convincing, is at least extremely plausible.

The train, be it remembered, was running at probably 70 miles an hour. There was absolutely no curve. There are no facing points. About 90 yards to the south, or London end, of the south end of the down platform there is a cross-over road between the up and down lines, the crossing of this connection on the down line being exactly 90 yards from the south end of the platform; about 70 yards to the south of the south end of the down platform there is a through trailing connection on the up main line, leading from the back platform line; this connection crosses the down main line 35 yards south of the end of the down platform; this crossing is at an angle of 1 in 6; and almost exactly opposite the south end of the down platform is a trailing connection on the down main line, leading from sidings on that side of the line. It is with these alone that we need concern ourselves. The cross-over road and the crossings were of the usual construction, well made, and in good order. The whole train had been carefully examined, and was in perfect condition. The driver's first intimation that an accident had occurred was a violent jerk, but his engine and tender kept the rails. The three leading coaches were derailed, but not upset. The fifth and sixth vehicles did all the serious mischief. The theory is that some coach near the middle of the train ran off the road at the V-crossing, and dragged with it those behind and before. But the first mark on the rails was not at the crossing, but some way in front of it. That is to say, actual derailment began before the crossing was reached. The V-crossing, too, was found intact. Further on, however, the track was torn up and disorganised. Here, again, theory suggests that the first mark visible was caused by a coach dragged off the road by the coach preceding it, which had been derailed at the crossing. Granting this, we have still to make out why any coach left the rails. After an exhaustive and able review of all the evidence Colonel Von Donop arrives at the conclusion that the platelayers had taken out a key while executing repairs and had not replaced it. The platelayers are explicit. They assert that no key was taken out. On the other hand, a shunter affirms that he saw the train leave the rails, and that a rail "jumped up" because the key was out. Now, it is by no means easy to believe that the absence of a single key could leave a rail, particularly at a crossing, free to "jump up," or that, if it did, the looseness of the rail would suffice to turn a coach off the road. The evidence is, besides, doubtful. It was not given until six weeks after the accident by a man who was badly hurt at the time.

We think Colonel Von Donop is quite justified in saying that the evidence of the platelayers and of the shunter who spoke of the missing key is open to doubt; but, on the whole, he inclines to the belief that the platelayers who were packing up the road were the indirect cause of the catastrophe. In his own words:—"It is impossible, I consider, to resist the conclusion that the derailment at this point was probably due to a weakening of the line at the knuckle timber, owing to the work which was being carried out by the platelayers. It is possible that these men had exceeded instructions, and had removed some fastenings, and that on the approach of the train they were engaged in restoring them, but that they had not time completely to do so before it arrived." Yet there is the fact which cannot be got over, namely, that the mark of the first derailment was in advance of the crossing—that is to say, a coach had apparently left the rails before the weak place was reached. Colonel Von Donop writes with no certain convictions. His theory is the best possible, and as such we accept it as sound; but, none the less, much remains open to doubt, and we fear that the Witham accident must be added to the list of those for which no satisfactory explanation has been found.

CHARING CROSS STATION ROOF.

ON Tuesday afternoon last a large portion of the roof of Charing Cross Station at the river end collapsed, killing and wounding a number of persons, and in its fall throwing down part of one of the lofty side walls upon the Avenue Theatre. Of the cause of the failure it is as yet too soon to speak. It is possible that some event immediately preceding the rupture led up to it or, on the other hand, it may be shown, when the official inquiry is held, that natural processes of decay which have escaped detection or defied remedy are alone responsible. Grounds for believing that the fracture of a tie rod immediately preceding the collapse are not wanting. Such an event would be an ample and sufficient cause, but would only move the problem a stage further back. Why a rod that had stood for forty years should suddenly fail presents an inquiry full of interest. That the failure was not due to structural weakness of design may be safely assumed from the fact that the roof has stood since about 1865, and that there was at the time no high wind or other cause of the kind which might, as in other cases, have been the immediate and evident cause. The roof, it is interesting to recall, was designed by the late Sir John Hawkshaw, and resembles not a little that over the New-street Station, Birmingham, built by Fox and Henderson some years before. The same design was used for the Cannon street Station and for part of Victoria Station. Both the Cannon-street and the Charing Cross roof were severely criticised on æsthetic grounds at the time they were constructed, but we do not think their strength was ever called in question. Some years ago heavy rust flakes fell from the Charing Cross roof, and led to a close inquiry and to the work of scraping, painting, and repairing, which has been proceeding on the roof ever since, and on which workmen were engaged at the time of the failure. For some observations on the design we may refer our readers to our issue of January 9th, 1903.

THE APPRENTICESHIP QUESTION.

THE committee appointed to inquire into the best method of providing apprenticeships for children attending elementary and secondary schools in the County of London, have issued a comprehensive memorandum, of which the most interesting portion deals with the question whether a premium should or should not be paid. It appears from inquiries that have been instituted by this committee that the old system of indentured apprenticeship has been falling into desuetude, and that in the majority of industries it has almost disappeared; while only in a few trades can it be said to be the commonly recognised way of entering such trades. This is only confirmation of a fact which has been recognised and deplored for many years. Boys now enter workshops frequently under no obligation to remain longer than may suit their convenience or taste, and receive wages in greater or less proportion to their services. The old premium acted as deterrent to the lad's leaving his employment in mere passing caprice or under the inducement of some trifling increase in the weekly wages. In hopes that it might be possible to check the decline of apprenticeship, the committee considered the possibility of paying premiums themselves for certain selected lads, and were forced to the conclusion that such a method would be too costly. "In view," they say, "of the difficulties and expense attending the pursuit of such a policy, and bearing in mind that large funds are devoted to apprenticeship already, we are of opinion that the Council should not sanction the payment of apprenticeship premiums." This is a very sound and wise opinion from more than one point of view. It is not impossible that employers could be induced to accept lads of good character and ability nominated by the Council without the payment of a premium. This is already done in many trades, the lads being bound by indentures in the ordinary way for a given term of years, and his master having the same control over him as if a premium had been paid. Where the employer will consent to this plan and will enforce the lad's adherence to his part of the contract it seems to leave little to be desired.

THE TUNNELLING OF THE FAUCILLE.

SINCE M. Gauthier became Minister of Public Works in France he has been giving particular attention to the question of facilitating access to the Simplon, and when, as we announced some time ago, he showed a preference for the proposal to drive a tunnel through the Faucille, the discussion on this important engineering undertaking broke out afresh. There are few enterprises which have given rise to so much controversy in recent years as the Faucille tunnel. The more it is discussed the farther away we seem to get from a satisfactory solution. It is surrounded by difficulties of a financial, economical, and international character. As soon as one is swept away others take its place, until it becomes a question whether the Faucille will be tunnelled at all.

The proposal was first brought forward when the work on the Simplon threatened to complete the task of draining the international traffic from France which had already been begun by the St. Gothard. The only practical way of defeating this scheme was to utilise the Simplon itself by putting it into direct communication with the French railways. Unfortunately, the Jura range stands in the way, and the single line to Pontarlier, with its steep gradients and wide detours, is quite unsuitable for dealing with heavy traffic. Obviously the most direct means of communication would be to connect up the line at Lons-le-Saunier with Geneva by driving a tunnel through the Faucille, or rather three tunnels, having a total length of 33 kiloms. There were other projects which have been allowed to fall into oblivion, and at the present moment the only alternative to the Faucille tunnel is the construction of a line between Frasne in France and Vallorbe in Switzerland, whereby Pontarlier will be avoided, and the distance will be reduced by 17 kiloms. An Extra-Parliamentary Commission was first appointed to go fully into the matter, and it issued a report proposing the rejection of the Faucille scheme on account of its high cost, and approving of the Frasne-Vallorbe connection, which would only cost something like 21,000,000f., as against 150,000,000f., which was roughly estimated for the Faucille tunnel. On the proposed route being surveyed it was found that the Frasne-Vallorbe line offered serious difficulties. It would have heavy gradients, and would cross a high plateau, where, in winter, the railway might be frequently blocked by snow. This project was allowed temporarily to drop, the more so as a Ministerial circular to the various Chambers of Commerce brought an overwhelming consensus of opinion in favour of the Faucille tunnel. As this is an international undertaking, France is not disposed to start upon the work unless Switzerland will contribute a fair share of the cost. Geneva is ready to give 10,000,000f., but for this it must have the sanction of the Federal Government; and although there is a good deal of conflicting opinion as to what the intentions of the Government really are, there is reason for believing that Berne is not favourably disposed towards the Faucille scheme, which might divert traffic from the line it proposes to construct between Berne and Brigue, through the Lœtschberg or the Wildstrubel. Nevertheless, the Government at one time promised a subsidy towards the construction of the line between Frasne and Vallorbe. At the moment France is very doubtful whether her neighbour will consent to contribute a fair proportion towards the construction of the Faucille tunnel. The Frasne-Vallorbe scheme is therefore being revived, and in the recent debate in the Chamber of Deputies it was strongly advocated by the representatives of the north-east departments, who believe that their interests will be served quite as well by this line as by the more costly tunnel. At a matter of fact, the whole question is becoming complicated by local interests. While the Frasne-Vallorbe route satisfies the north-eastern populations, the centre of France favours the Faucille, while those south of the Loire claim that this enterprise would ruin the great traffic route to Marseilles.

Seeing, however, that the object of the Faucille tunnel is to prevent international traffic from being diverted through Ostend, Brussels, Namur, Metz, and Switzerland to the Simplon, the situation of Marseilles would be no worse than it is at present. Though the problem is a very complicated one, it is felt that some decision should be come to speedily for utilising the Simplon, not only as a means of saving the existing traffic, but of providing for the traffic which it is believed will grow up enormously with the construction of the Panama Canal. It is argued that the Atlantic ports are admirably situated for the traffic which will take place through the Panama Canal between Europe and the Far East if only there be direct communication with Central Europe; otherwise the traffic will go by way of Antwerp and Hamburg. As the Minister of Public Works has promised to bring forward a definite scheme for the construction of the Faucille tunnel, the question will soon enter upon a practical phase, but it is continually raising so many difficulties and side issues that it will probably be a long while before this great undertaking is put in hand.

THE NEW SCHEME OF TRAINING NAVAL OFFICERS.

By A FLEET ENGINEER, R.N. Ret.

THE recently promulgated Admiralty order will undoubtedly have far-reaching influences on the success of the new scheme of training naval officers. As first laid down those officers who specialised in engineering were debarred from rising above the rank of a rear admiral.

Possibly it was intended they should fill the positions of Admiral Superintendents of Dockyards, and Controller of the Navy, and other positions requiring special engineering knowledge, but the blue ribbons of the naval service were not apparently for them. This has been the blot in the new scheme. The Admiralty is to be heartily congratulated on its recent decision to allow any officer, no matter what he specialises in, the opportunity of rising to the top of his profession, believing that the sea-fighter of the future must be a blend of various accomplishments, not the least of which should be a sound mechanical training.

The question is being continually asked, will the engineer officer under the new conditions be as capable of keeping his machinery efficient as the existing engineer officer does? A visit to the Royal Naval College workshops at Osborne, which I recently had an opportunity of paying, gave me the impression that he will; and a short account of his training, especially in engineering, will, I think, prove of interest to your readers.

The cadets enter at the age of 12½, and the number under training is about 410. They remain two years at Osborne, and all go through exactly the same course, and about one-third of the time is devoted to practical engineering.

The shops are about ten minutes' walk from the College, and comprise a machine and fitting shop, carpenters' shop, pattern shop, brass foundry, smithy, coppersmith shop, and drawing-office, also two lecture rooms.

The youths begin by making their own callipers and other small tools, and I can vouch for the first pair I examined—it was by a youth bearing a well-known name—as having no "headache," and working without jump. Very good lathe and machine work is done even during the first term. The youth makes his own pattern, and afterwards moulds and casts the article. In the smiths' shop swinging a sledge hammer is practised on a large iron punch in a block of hard wood. Drawing square bars into round, and the opposite, and welding bars is also taught, and very satisfactorily performed, as well as the fettling and tempering of tools. The small coppersmiths' shop is used for brazing and bending pipes, and for re-metalling brasses. An excellent course in drawing is given, the cadets doing their own rough sketching, taking measurements, and making the drawings and tracings.

Attached to the College there is a cruiser, torpedo boats, and the Betà, which is a large steam launch with water-tube boiler, compound engines; in fact, a miniature of larger machinery. A covered lecture-room with table and seats, being a part of the engine-room, enables tabulation of notes on experiments, sketching of details, &c., examinations, and re-connections. Incidentally, also, these vessels train the stomachs and legs during trips in foul weather. The course of tuition is shown in the accompanying tables.

Very few premium apprentices in engineering establishments receive such an education. There is always an instructor at the elbow, and there are no idle moments. The whole course is mapped out to teach engineering as required in the Navy. From the outset great pains are taken to impress the cadets with the fact that, no matter what he specialises in, a knowledge of engineering is necessary, and that not only the engineer officer, but also the gunnery and torpedo officer, have charge of much machinery.

Entering the workshops, one is struck by the ancient reminder "Asque Labore Nihil," in large brass letters—home made—over the entrance. A large washing place with dozens of basins, having hot and cold water, pegs for hanging the combination dungaree suits, conduce to quick changes when leaving the workshop for the lecture room.

Sundry types of new and old engines of various sizes and designs, complete in all details, some with cylinders cut to section, and a surface condenser, are provided for sketching, for dismantling, and practice of various operations. Each cadet has a workshop note-book, one side section ruled for recording any items of utility. Perusal of these shows that acquirement of knowledge is keen. Sketches of a screw propeller, with names of parts, the pitch delineated, &c.—this, I think, was Royalty's book—tables of Whitworth threads, notes on tempering tools in which "straw colour" is of great importance, and many other schoolboy notes, all showed that the training was being carefully followed, and none of the notes were other than practical and useful. Lecture rooms with blackboards in squares, in which on entrance the first order is to take up pencil and compasses, and the last to return the same to their receptacles, all showed well thought-out plans for imparting knowledge in a way easily understood, and for celerity in passing from stage to stage.

The hammer and chisel is mastered, though even Royalty and all others find that there is no royal road to this acquirement, the knuckles having to pay the usual price, and the grit is apparent, for without doubt this is a most trying task in learning.

A very good feature has developed, some of the cadets having already budded as inventors, and on wet Saturday afternoons, at the cadets' request the privilege has been accorded of running the machinery in the factory and doing what they like. Various inventions and contrivances are in evidence, including a model of a battleship in aluminium, to be self-propelled.

Speaking commercially, I am of opinion that the engineering course, in being and design, is such that it would honestly be worth £1000 paid as a premium in a private establishment. In fact, no doubt the cost to the country of each naval officer by the time he reaches sub-lieutenant's rank will be over £1500.

All through the tuition at Osborne, utility seems to be the gauge. Great attention is given to French; this is just and proper, for there is no doubt French is the "Mandarin" language among Caucasians. On Saturday evenings French plays are occasionally performed, and seem to be well understood, as shown by the spontaneous hearty laughter.

Nor is the facility for acquiring engineering knowledge confined to Osborne. Within a few minutes' walk are the extensive works of J. S. White and Co., shipbuilders and engineers, employing some 1500 men, at Southampton the works of John I. Thornycroft and Co. and Day, Summers and Co., Ld., and these, with the Dockyard at Portsmouth, offer valuable lessons when visited in the company of instructors capable of pointing out what is good and new, and new and good.

Instructions in arms is fully carried out. It is said with pride that recently, at the Military Tournament, two of the cadets carried away the prizes for broad sword combat against the cadets of the Military Academy, though the naval Davids were of far less stature than the military Goliaths.

With a lawn capable of allowing seven cricket or football matches in full swing, it is only natural that open-air games suggest themselves, and are indulged in to the full. So that each day's work, both physical and mental, soon causes the healthful sleep at 9 p.m. in the well-ventilated and pleasant dormitories, and at daybreak the old worded behests to "rise and shine" or "show a leg" or "tumble out," soon cause the fifty occupants of each admiral-named dormitory to be washing and splashing under fountain sprays, followed by a plunge in a large bath, heated, if necessary. Even the ancient proverb of the midshipman's chest having everything on top and nothing handy seems to be belied, order in all being insisted on; the hanging the dungaree suit on its peg, or the towel on its hook, the placing of callipers, centre punches, and other tools in their drawers, all these acts are part of the automatic discipline.

Discipline seems to be self-acting. There is an indescribable punishment which consists in being placed in the "schoolboy class." This means a separate table at meals, and, generally, that the youth has reverted to the boy stage, and is no longer a naval officer.

The dieting is good. A glance at the various meals for different days would lead one to remember schoolboy days, and feel envious that variety and quantity were not so in former times. Speaking with pleasant remembrance of some naval dishes, one can only note that "sea pie" is absent, and not seldom has the "old salt" affirmed that "sea pie won the battle of Trafalgar."

The head captain is of no mean authority. This cadet is charged with various responsibilities. It was a pleasure to the writer to observe 200 white-clothed and white-hatted cadets, in flannel trousers and shirts and soft hats, being marched by the head captain from Osborne to Kingston through the pleasant fields, used as fowl runs and for hay, and to see the orderly progress and dispersion of these cadets, some donning their dungarees, and in a few minutes taking up with lathe and machine work, some at the carpenters' bench or wood lathe, some at the forge, the foundry, and coppersmiths' fire, others in lecture-rooms, all in what might be called deadly earnest.

In conclusion, let me confess I went to Osborne a disbeliever and scoffer, prepared to find the cadets "fiddling with files," and becoming amateur engineers generally. I left fairly convinced that it was a very genuine and thorough system, with a wish at the back of my head that I could begin life again, and in such a manner. The sight of those hundreds of young officers, working as they were, impressed me more than I can say, and I augured that the future of our Navy is well assured, and that duty would represent its future—as in the past—spirit.

I trust that at some future time I shall have an opportunity of visiting the Dartmouth College, to which, after two years at Osborne, the cadet is transferred. Here a similar, but, of course, more advanced course of training is carried out, the cadet still spending about one-third of his time in learning engineering. After two years at Dartmouth he goes to sea for three and a-half years; one-third of this time, again, is spent under the chief engineer officer of the ship. The usual sub-lieutenant's course follows; after that specialisation—in engineering, gunnery, torpedo, navigation, or marines. This additional course in engineering lasts from one to three years; and, with the groundwork already thoroughly laid, I opine that in the future we shall have as good engineer officers as we have had in the past.

The old order has changed, mechanism being now the acme of sea battles. It is pleasant to record that our young aspirants are putting all their brains and energy into mastering details for fighting proficiency in a manner even more strenuous than in former days of "hands by the lower halyards," "lay out, take in three reefs," the days of shank painters, clew garnets, tacks and sheets, days which gave us naval officers second to none, which proud position we may rest content in believing is not at an end.

I send you two sheets from the syllabus, which show the order of the classes and the time spent on the various subjects:—

REVISED ENGINEERING SYLLABUS.—LECTURES.

First Term: Two Lectures per Week.—Elementary Mechanical Drawing. General arrangements of Machinery in a Ship. Motion obtained by suitable Engines from Fluids or Gases moving at speed or applied with pressure. Names of parts of Structures and nature of Forces they withstand. Shafts and Bearings. The Screw Propeller and Steam Turbines. Thrust and Thrust Bearing. Reactions in simple Reciprocating Engine and simple Turbine. Rivets, Bolts, Studs, and Nuts. Keys. Couplings and Clutches.

Second Term: Two Lectures per Week.—*A: Recapitulation. Cocks and Valves. Simplest Slide Valve. Cycle of Steam in Reciprocating Engine. D-Slide Valve without Lap or Lead. Position of Excentrics or Ahead and Astern. Reversing by Differential Valve. Piston Valves. Non-return Valves. Lift and Force Pumps. Cycle of 4-stroke internal Combustion Engine. Pistons. Glands. Cylinder Clearance. *B: Pawls. Excentrics. Lubrication. Means of taking up wear in Bearings. Cams.

Third Term: One Lecture per Week.—A: Recapitulation. Boilers and Fittings. Condenser and Fittings. B: Pulley Gearing. Wheel Gearing. Worms. Bevel Wheels and Reversing by.

Fourth Term: One lecture per week.—A: Materials, Properties, and Use. Effect of Heat on Materials, Expansion Joints of Pipes and Cylinder Liners. Pressure Volume Graphs. Force. Work. I.H.P. Expansion of Gas or Steam without involving Heat. Slide Valve, with Lap and Lead. Excentrics, with Angular Advance. Modification of Pressure Volume Curves due to gradual action of Slide Valve. B: Universal Joint. Trains of more than two Wheels in Gear. Machine Back Gear. Screw Cutting. Change Speed Gears. Quick Returns. Feed Motion, Drilling Machines.

Fifth Term: One Lecture per Week.—Enumeration and Explanation of Working and Uses of all parts in a small Reciprocating Steam Engine Installation. Sketches of Water Gauge. Steam Gauge. Self-closing Valves. Equilibrium Valve. Piston-rod Connections. Metallic Packing. De Laval Turbine, &c.

Sixth Term: One Lecture per Week.—Heat: Temperatures, Quantity. Mechanical Equivalent of Heat. Energy and Conservation of Energy. Advantages of High Pressure and Temperature of Steam or Gas and High Rates of Expansion. Reciprocating Engine. Cylinder Condensation and Exhaust Waste. Stage Expansion. Steam Jackets. Superheated Steam. Wire-drawing and Drop. Linking up. Link gear. Steam Turbine. Single Stage Turbine. Conversion of Heat Energy to Kinetic Energy. Speed of Steam. Angle of Blades. Difficulties of Economical Running at Slow Speeds. Multiple Stage Turbines. Compounding of Turbines.

NOTE.—Lectures are also given on workshop practice and appliances as necessary.

Practical Course of Engineering—Royal Naval College, Osborne.

Term.		Work.			
1st ...		Carpenters' Shop, 1st 6 weeks Machine Shop, 2nd 6 weeks			
2nd		Machine shop, 12 weeks			
3rd ...		Instructional Engines, 1 week "Beta," 2 weeks Marking-off Class, 2 days Machine Shop, 9 weeks			
		A PART.	B. PART.	C. PART.	D. PART.
4th	(a)	Sketching, 1 week Foundry, 5 weeks	Coppersmiths' Shop, 1 week Machine Shop, 5 weeks	Sketching, 1 week Machine Shop, 5 weeks	Coppersmiths' Shop, 1 week Smithery, 5 weeks
	(b)	Coppersmiths' Shop, 1 week Lathe Class, 3 weeks Machine Shop, 2 weeks	Sketching, 1 week Foundry, 5 weeks	Coppersmiths' Shop, 1 week Pattern Shop, 5 weeks	Sketching, 1 week Pattern Shop, 5 weeks
5th	(a)	Drawing-office, 6 weeks	Torpedo Boat, 1 week Lathe Class, 3 weeks Machine Shop, 2 weeks	Foundry, 6 weeks	Torpedo Boat, 1 week Machine Shop, 5 weeks
	(b)	Torpedo Boat, 1 week Smithery, 5 weeks	Drawing-office, 6 weeks	Torpedo Boat, 1 week Lathe Class, 3 weeks Machine Shop, 2 weeks	Foundry, 6 weeks
6th	(a)	Machine Shop, 6 weeks	Smithery, 6 weeks	Drawing-office, 6 weeks	Lathe Class, 3 weeks Machine Shop, 3 weeks
	(b)	Pattern Shop, 6 weeks	Pattern Shop, 6 weeks	Smithery, 6 weeks	Drawing-office, 6 weeks

*A. Lectures dealing with the fittings and means of controlling the working fluid.

*B. Lectures dealing with the methods of communicating forces and motions by rods, cams, wheels, &c.

PRINCES RISBOROUGH AND GRENDON UNDERWOOD RAILWAY

Fig. 1—HARROW ROAD STATION

Fig. 2—VIEW OF LINE AT SOUTH HARROW STATION

Fig. 3—TUNNEL UNDER THE DISTRICT ELECTRIC LINE

Fig. 4—THE WEMBLEY CUTTING

THE NEASDEN AND GRENDON UNDERWOOD RAILWAY.

THE Great Central new main line between Neasden and Grendon Underwood, 46¼ miles in length, was fully described in the issues of THE ENGINEER for May 27th, 1904, and July 14th, 1905. As briefly announced in our last issue, the line was open for through goods and mineral traffic on November 20th, and according to present arrangements the intention is to open it for the through fast and short-distance passenger traffic in February next. The accompanying illustrations depict representative views of the line between Neasden and Northolt Junction, which, it will be remembered, is the sole property of the Great Central Railway, the line between Northolt and Grendon Underwood, *viâ* High Wycombe and Princes Risborough, being Great Central and Great Western joint. Fig. 1 shows the line at Harrow-road Station, looking towards London. This is the largest station on the Neasden-Northolt section, and is situated on an embankment. Fig. 2 is a view of the line at South Harrow Station, also looking towards London. These two engravings show clearly the arrangement followed in the case of each intermediate station throughout the line, the "fast" lines being kept away from the platforms, and the latter reached by loops. Fig. 3 represents the "cut and cover" tunnel underneath the District Company's electric line between Ealing and South Harrow. The cutting in which this tunnel, 9 chains in length, is situated is 2 miles 55 chains long. Owing to the limited head room available, and the "live" rails of the District Railway, the construction of the tunnel was a very difficult undertaking. Under the railway itself the construction takes the form of a steel bridge, 80ft. long, on the skew. Fig. 4 shows the Wembley cutting. The excavation of this cutting necessitated the removal of 600,000 cubic yards of material—London clay. The cutting is a little over one mile in length, and on the north side is 70ft. deep. In consequence of the enormous amount of land which would have been required for the slopes had they been taken from rail level, the sides were bolstered with retaining walls to about half the height of the cutting. Each wall is 1617ft. in length, and that on the north side attains a height of 40ft. Four lines of way extend from Neasden to the western end of the cutting.

CONFERENCE ON SMOKE ABATEMENT.

THE Royal Sanitary Institute, in conjunction with the Coal Smoke Abatement Society, have arranged to hold a conference on Smoke Abatement in the Royal Horticultural Society's Hall, Vincent-square, Westminster. The conference will last three days, commencing December 12th, and continuing till the 15th. There will be an exhibition of grates, stoves, cooking plant, heating flues, chimney construction, and smoke consuming and preventing appliances. The conference and exhibition will be opened on Tuesday evening, the 12th inst, when the chair will be taken by His Grace the Duke of Fife. The presidential address will be given, after the formal opening of the conference, by Sir Oliver Lodge, the subject chosen being "The General Problem of Combustion Reform." On Wednesday the subject for the day will be "Domestic Smoke Abatement." The chairman for this day will be Sir George Livesey. The meetings commence at 11 o'clock, when the following papers will be read, not necessarily in the order given here:—Dr. H. A. Des Voeux will deal with "The Abatement of Smoke from Private Houses." Mr. A. S. E. Akermann has chosen "The Distribution of Producer Gas as a Means of Alleviating the Smoke Nuisance" as his subject. Sir Charles Cookson will read a paper on "Coke as a Domestic Fuel." Miss M. Agar, of the Metropolitan Gardens Association, will read a paper on "The Effect of Smoke on Plant Life." Prof. J. B. Cohen will give a "Record of the Work of the Leeds Smoke Abatement Society," and, lastly, Dr. S. Rideal will read a paper on "The Acids of Smoke." A visit will be paid in the afternoon to the Chelsea generating station of the Underground Electric Railways Company of London, Limited. The chairman for the meetings to be held on the Thursday will be Sir William Preece. The subject for the day will be "Factory and Trade Smoke Abatement." There are to be only four papers read dealing with this problem. Commander W. F. Camborne, C.B., F.R.A.S., F.R.G.S., F.R. Met. Soc., will read a paper on "Stoking and Smoke Abatement." Dr. Rideal, F.I.C., will give "A Report based upon Returns furnished by Manufacturers who have succeeded in securing the Abatement of Smoke in Factories." "The Aims and Work of the Hamburg Smoke Abatement Society" will be described by Mr. John B. Kershaw, F.I.C.; and Mr. Joseph W. Lovibond will give the last paper, on "The Precautions necessary for Making Reliable Observations of Smoke Densities." The gasworks of the South Metropolitan Gas Company at Old Kent-road will be visited in the afternoon. "Administration, Legislation, and Necessary Reforms" is the subject for the last day. The chairman will be Sir William B. Richmond. The meetings will commence at the usual time—eleven o'clock—when the following papers will be read:—"Notes on the Proposed Amendment of Section 24 (Sub-section 6) of the Public Health Act, London, 1891," by Mr. Julian S. Corbett; "English Law relating to the Emission of Smoke from Chimneys," by Mr. Joseph Hurst; "Report upon Returns furnished by Local Authorities with regard to the Carrying Out of their Powers and Duties in the Matter of Smoke Nuisances," by Mr. Lawrence W. Chubb, secretary to the Coal Smoke Abatement Society; and "The Artificial Production of Fog," by the Hon. Rollo Russell. Mr. Arthur Rigg, on behalf of the Royal Botanic Society of London, will also read a paper on "The Deleterious Effects of Coal Smoke on Plants Growing in the Gardens of the Royal Botanic Society of London;" while Mr. W. N. Shaw has chosen as the title of his paper "Is London Fog Inevitable?" The last paper in the programme is "Smoke Abatement from the Sanitary Inspector's Point of View." The visit to be made on this day will be to the Abbey Mills pumping station, London sewage outfall works. Conference tickets can be obtained from the offices of the Institute, 72, Margaret-street, London, W.

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETING.—The first of the students' meetings for the session 1905-1906 was held at the Institution on Friday evening, the 1st inst., the President, Sir Alexander R. Binnie, in the chair, when a paper on "An Installation for the Bacterial Treatment of Sewage at Neath" was read by the author, Mr. W. L. Jenkins, Stud. Inst. C.E. The reading of the paper was followed by a discussion, in which Messrs. H. E. King, H. S. Watson, R. J. Francis, C. H. Kilmister, I. J. Thatcher, J. M. S. Culbertson, and C. W. Wheen, Studs. Inst. C.E., took part.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

THE BALANCING OF PETROL ENGINES.

SIR,—The article on the balancing of a multi-cylinder petrol engine in your issue of the 17th November is so interesting that it seems desirable to consider how far the conclusions apply to engines of larger dimensions, particularly with reference to marine work and to engines using a heavy oil, where the mean pressure is less than that obtained with petrol, and which are therefore, *ceteris paribus*, heavier per brake horse-power.

Your correspondent, in the article referred to, starts with a choice of crank angles, and states that the spacing of the cylinders and ratios of reciprocating masses are of minor importance. No doubt this may be true of a small petrol engine, but in larger engines for marine work the weight and space occupied become of primary importance, and less simple angles could be accepted if weight and space could be saved thereby.

Your correspondent shows that in a four-cylinder engine, neglecting secondary couples and arranging the cylinders symmetrically, both as regards reciprocating weights and crank angles, about the centre of the engine, the conditions of balance become

$$W_1 \cos \theta_1 + W_2 \cos \theta_2 = 0 \quad . \quad . \quad . \quad . \quad (12)$$

$$W_1 a_1 \sin \theta_1 + W_2 a_2 \sin \theta_2 = 0 \quad . \quad . \quad . \quad . \quad (13)$$

$$W_1 \cos 2\theta_1 + W_2 \cos 2\theta_2 = 0 \quad . \quad . \quad . \quad . \quad (14)$$

From (12) and (14) we have at once that—

$$\cos \theta_1 = \sqrt{\frac{W_2}{2 W_1}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (i.)$$

$$\cos \theta_2 = -\sqrt{\frac{W_1}{2 W_2}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (ii.)$$

and by substitution in (13) we get—

$$\frac{a_1}{a_2} = \sqrt{\frac{W_2 (2 W_2 - W_1)}{W_1 (4 W_1 - W_2)}} \quad . \quad . \quad . \quad . \quad (iii.)$$

In practice, where space is a consideration, cylinders 1 and 2 would be kept as close together as possible, likewise cylinders 3 and 4, but according to the plan proposed, Nos. 2 and 3 would be widened out as far as space permitted so as to reduce the ratio of W_2 to W_1, or, in other words, to reduce the weight which must be added to the reciprocating parts of the inside cylinders to bring about the required condition of balance.

If the available space therefore is fixed, the ratio of $\frac{a_1}{a_2}$ is known. Let this be "n." Then treating (iii.) as a quadratic in $\frac{W_2}{W_1}$ we get—

$$\frac{W_2}{W_1} = \frac{\sqrt{(n^2 - 1)^2 + 16 n^2}}{4} - \frac{n^2 - 1}{4}$$

which gives the ratio of the weights when the space is fixed and the crank angles follow at once from (i.) and (ii.).

In the particular case where all the cylinders are as closely pitched as possible $n = 3$ and $\frac{W_2}{W_1}$ become approximately 1·6, or the weight of the reciprocating parts of each of the inside pair of cylinders has to be increased by 60 per cent. over the corresponding weight for each of the outside cylinders.

If we take the same space as a five-cylinder engine would occupy, but omit the middle cylinder, n becomes $= 2$, and $\frac{W_2}{W_1} = 1{\cdot}39$. Similarly, if we take the same space as a six-cylinder engine would occupy and omit the two middle cylinders, n becomes 1·66, and the added weight 25 per cent.

The spreading out of an engine means additional weight in lengthened base-plate, crank shaft, and columns, for which no return is obtained, and in the case last supposed this weight, together with the weight added to the reciprocating and revolving masses, would much better be utilised in fitting two additional cylinders in the empty space in the centre of the engine. Practically, then, this method of balancing would only be convenient where the spreading out of the engine did not exceed the space required by one cylinder and the added weight to the reciprocating parts of each of the two centre cylinders will then be from 40 to 60 per cent. of the corresponding weights of the outside cylinders.

The addition of weight to reciprocating parts is always undesirable, and becomes the more so as the size of the engine is increased, and, though it would be unwise to say that the addition indicated above is impracticable, it is not a contingency that one can regard with equanimity.

There are two other objections at least to this system as applied to large engines. One has been pointed out by a correspondent in your issue of the 24th, viz., the lesser uniformity of turning moment. This has a direct bearing on any investigation of balancing where uniform angular velocity is assumed. In large marine engines the diameter of the fly-wheel will be limited by the position of the centre line of the shaft. Large moment of inertia is, therefore, not possible without large weight of rim, which may become very great if a reasonably constant angular velocity is to be obtained. The other objection, which is specially applicable to marine work, is that there are two sets of pistons, connecting-rods, &c., and consequently lack of interchangeability, and necessitating the carrying of double the number of spares.

The conclusion to which one seems to be drawn is that the advantages obtained by balancing a large four-cylinder engine by the method proposed do not compensate the disadvantages; and as a general rule it would be better to arrange the cranks in the usual way and to keep the speed of revolution below such a point that the secondary forces and couples can be accepted.

It will be noted that the same objections apply to a five and to an eight-cylinder engine.

With a six-cylinder engine, as your correspondent shows, the reciprocating weights are required to be all equal, and the cylinders placed symmetrically. The turning moment of such an engine is good, and for powers of several hundred horse-power at high speeds of revolution, and where space can be allotted for it, this arrangement has practically everything in its favour except cost, which must necessarily be higher than an engine of the same power with fewer parts.

H. C. A.

Grantham, November 29th.

SIR,—The remarks of your correspondent, Mr. Rowledge, with reference to my article on the "Balancing of Multi-cylinder Petrol Engines," give me the impression that he has failed to grasp the real significance of the question at issue. While it is quite evident that the turning moment in the proposed balanced four-cylinder engine is not of such a uniform character, if he will go to the trouble of estimating the maximum variation in turning moment in the two types of engine with the same indicator diagram for each cylinder he will find that it is not so serious as he seems to think. In a case I have investigated, the ratio of the maximum variation to the mean turning moment was 1 in the ordinary type and 1·6 in the balanced type of engine. Hence, if the same degree of uniformity of revolution was desired it would only be necessary to increase the moment of inertia of the fly-wheel in the ratio 2·6 : 2.

But there can be no question that the deleterious effects of an unbalanced force of high frequency, and of the magnitude given in the article, is of far more serious importance than the cyclical variation of the turning moment at the high speeds of revolution—a fact which I have hardly exaggerated. These effects are well known to drivers of motor-driven craft, although often wrongly attributed to other causes, and they are quite independent of the condition of the sea.

The cushioning effect of the advanced spark is also a matter of common experience, and Mr. Rowledge will find, on reading the article more carefully, that a reference is made to the question.

I entirely fail to see how the article advocates the use of a number of small cylinders for motor engines.

In good practice the parts of each cylinder are made interchangeable, thus reducing first cost, and also there is nothing in the performance of the motor engine which corresponds to the receiver losses in steam engine practice. Mr. Rowledge's method of adapting the different types of motors for the propulsion of small craft, from the canal barge to the pure racing boat, is no doubt very interesting, but it has little bearing on the fundamental principle of the article.

In conclusion, I may say that if all the disadvantages of the proposed balanced four and five-cylinder engines are enumerated in his letter, it seems to me that the next step is to find from practical experience whether its many decided advantages do not entirely outweigh them.

THE AUTHOR OF THE ARTICLE.

London, December 4th.

EFFICIENCY OF FLASH BOILERS.

SIR,—In your issue of 1st December "Horse-power" asks for information regarding the efficiency of flash as compared with water-tube boilers.

My experience is that he may expect an efficiency of 30 per cent. in favour of the flash boiler, provided it is properly worked, for it is not practicable to generate and supply saturated steam from it unless properly worked. Moreover, the best results can only be attained when it is used in combination with a good design of engine.

Regarding the publication of a work on the flash boiler, I doubt if he will find one which will answer his purpose. So far, steam superheated to its highest grade of efficiency has apparently only been used on small engines. There is, however, no insuperable difficulty in using highly superheated steam with large engines. Should "Horse-power" decide on using flash boilers he will be rewarded with gratifying results. It is to be hoped that he will not be led away with the belief that the superheating of steam in a separate receiver will give equally good results. Nothing short of using steam superheated to its highest degree direct from the generator will allow of the highest efficiency.

JOHN RIEKIE.

Argaith, Dumbreck, December 4th.

VENTILATION OF "TUBE" RAILWAYS.

SIR,—A point that has occurred to me in connection with the subject of "tube" railway ventilation is that all the stations should be provided with fans, and made upcast and downcast shafts in alternation—that is, while air was driven downwards at stations 1, 3, 5, &c., it would be drawn upwards at stations 2, 4, 6, &c. The passage of trains would not interfere with the general flow from 3 and 5 towards 4 lying between them, and no troublesome arrangement of automatic doors, &c., would be necessary. At stated intervals a change along the whole line might be effected, stations 2, 4, 6, &c., becoming downcast, and 1, 3, 5, &c., upcast.

It seems to me that this should prove a very simple solution of an admitted difficulty in "tube" working, and should make the conditions underground much more tolerable than they are at present.

London Institution, E.C., December 4th. A. J. ALLEN.

NAVAL ENGINEERS.

ON Monday last a Blue-book entitled "A Statement of Admiralty Policy," was published. It may be divided into two principal parts; the first "A Memorandum on Admiralty Work and Progress;" and the second "Notes on Some of the Principal Reforms Undertaken by the Admiralty, 1903-5." From these two parts the following abstracts, referring principally to the training of engineer officers for the Navy, are taken:—

DEVELOPMENT OF THE NEW SYSTEM OF ENTRY AND TRAINING OF OFFICERS.

When the new system was introduced in 1902, the Board felt that owing to lack of experience and of sufficient data they were not justified in holding out to all candidates who should enter for the three branches—Executive, Engineering, and Marine—the hope that they might eventually become captains of ships and admirals of fleets. It was premature then to declare that it would be possible to do away completely with the distinction between the three branches when the officers reached the rank of lieutenant.

That the general efficiency of the Navy would be much assisted by the removal of this distinction was to them beyond doubt, but there was no necessity to come to an immediate decision upon this point, and accordingly, without in any way tying their hands, or those of their successors in the future, the Board considered it best to assume that the division into the various branches would be definite and final.

In order, therefore, to allow the Admiralty a completely free hand, no candidate has been accepted who has not volunteered for any one of the three branches.

It will be remembered that in order to provide for the new cadets during the first two years of their training at the age of from 12 to 14, a new college was built at Osborne, and a new system of education and training has there been inaugurated with great success.

The progress of the cadets during their first two years has been most carefully watched, and at the close of this period the Board felt that the experience gained warranted them in instituting a detailed inquiry into the probable future development of the new officer.

A Committee was appointed under the presidency of the Commander-in-Chief at Portsmouth, Admiral Sir Archibald Douglas, G.C.V.O., K.C.B., to consider whether the time has arrived to formulate regulations for the allocation of the duties of future officers in the various branches of the Service, and to report:—(*a*) Whether any necessity exists for the distinct classification of such officers under existing branches of the Navy, with a view to their remaining specialised for the whole of their future service. (*b*) Whether specialisation for a period of their career only is necessary; and if so, to indicate the procedure that should be followed to carry out the necessary duties of the Service afloat. (*c*) How best to provide for filling efficiently the higher scientific appointments of the Admiralty and dockyards.

The report, which is discussed in detail in a separate note, has convinced the Board that there will be no need for a final division into the three branches, and that specialisation for a period only is necessary, as opposed to permanent classification into separate lines.

There can be no question of the great advantage to the efficiency of the Service that this removal of differences will entail.

ENGINE-ROOM WATCH KEEPING.

Sir Archibald Douglas's Committee was also asked to report on the methods for providing warrant officers capable of taking charge of the stokehold and engine-room watches, so as to relieve the more highly-trained officers of the ship from the routine duty of engine-room watch keeping.

It has long been felt that the stoker class should have better opportunities of advancement, and in the memorandum of December, 1902, the creation of the new chief petty officer rating of mechanician, to be filled from the stoker class, was announced.

Further consideration of the various duties in the stokehold and engine-room led the Committee to recommend that in future the highly-trained engine-room artificer class should not, as heretofore, be called upon to undertake ordinary watch-keeping duties, but should be enabled to devote all their time to their real calling of artificers, and that watch-keeping duties should be undertaken by men selected from the stoker ratings after a suitable course of instruction.

The Board have adopted this policy, and the stoker ratings will in future be eligible for promotion to warrant officer-rank for duty as engine-room watch keepers.

NOTES ON SOME OF THE PRINCIPAL REFORMS UNDERTAKEN BY THE ADMIRALTY, 1903-1905.

EDUCATION OF OFFICERS.

The reorganisation of the entry and education of executive, engineer, and marine officers, which was commenced in 1903, has now been in force for over two years, and it is satisfactory to find that the anticipations of success entertained by the Admiralty have been more than fulfilled. Reports on the training by independent experts have fully confirmed this anticipated success.

The cadets are selected for nomination at the age of 12½-13, after being seen by a Committee which advises the First Lord as to their suitability, and those who are nominated are admitted to the Royal Naval College at Osborne after passing a simple qualifying examination in the usual subjects taught in a good preparatory school.

Two years are spent at Osborne, and the cadets then pass on to continue their training in the new college at Dartmouth.

The course in the Naval Colleges gives them a thorough grounding in English, French, history—general and naval—geography, mathematics, mechanics, physics, and engineering, as well as an introduction to navigation and seamanship. A large share of their time is given to acquiring in the engineering workshops, with which both colleges are provided, practical knowledge of the use of tools and engineering processes generally, and in learning to drive and handle engines. The study of mechanics and physics is also made as practical as possible by means of laboratories, and the elementary parts of seamanship are learnt in boats and cruisers attached to the training establishments.

In many respects the system of training differs widely from that of an ordinary school. So far as experience has yet been obtained, it is satisfactory. The boys are keen, and for the most part highly receptive. Their practical work and drill gives variety to their studies, and their interest is maintained by giving them short periods of very efficient teaching in small classes, with frequent change of subject. To attempt with such young boys the serious study of engineering was a novel experiment; the results have proved successful beyond expectation, and the practical habit which the engineering work begets is found to re-act favourably on the other studies.

After completing four years' shore-training in the Osborne and Dartmouth colleges the cadets will join a sea-going cruiser for about seven months, where the training will be continued, and will have a more practical turn given to it. It is confidently anticipated that these midshipmen on leaving the training cruisers will be fully as capable of taking the Part I. examination in navigation and general subjects as the present midshipmen are on completion of their sea service, and that it will only be necessary for them to keep up this knowledge whilst learning the practical subjects of their profession at sea. The midshipmen of each ship will be divided into sections for the purposes of instruction; one section working on deck with the commander, one working below with the engineer officer, another with the gunnery and torpedo lieutenants, &c., and the period of instruction in each branch will be continuous for two or more months. Examinations will be held annually, and will embrace papers on general mathematical subjects, in addition to the practical subjects of the instruction at sea. The period of instruction at sea will be three years, and at the end of this time midshipmen will be called upon to pass their examinations in seamanship and engineering before boards of officers. If successful they will become acting sub-lieutenants, and seniority will be determined according to their success in passing from the cruiser as midshipmen. After passing for acting sub-lieutenant they will be discharged from their ships to return to England, and soon after arrival will undergo the examination in Part I. of navigation and general subjects. This will be succeeded by short courses and examinations in pilotage, gunnery, and torpedo. At the termination of these courses they will be confirmed in their rank of sub-lieutenant, and those who have done sufficiently well will be selected for a further course of study in general subjects leading up to Part II. of the examination. This course will be designed mainly as a preparatory training in science for those officers who will afterwards become specialists in gunnery, torpedo, engineering, or other subjects.

It will be remembered that the broad aim of this new system was to enter in one common entry sufficient officers to supply the needs of the executive, engineering, and marine branches of the Navy, and to educate all these young officers for four and a-half years in all the subjects connected with the three branches, so that when they went to sea as midshipmen they would be in a fit state to benefit by the practical experience there available. After serving for three years at sea they would be examined for sub-lieutenant. Special attention was paid to instruction in engineering, so as to ensure as thorough a grounding in that subject as is now given to engineer students. It was then tentatively proposed to let the young officers split into separate special branches, in which they would remain for the whole of their careers.

It was impossible in 1903 to decide fully all minor points in connection with the scheme, and especially prominent among these was the question of the method of the distribution of the officers among the three branches concerned. The Admiralty felt, at the time, that the question was one that could only be answered when experience of the result of the early years of teaching was forthcoming; if the results were in all respects what they had reason to hope, then the need for life-long specialisation would disappear; if, however, difficulty was experienced in obtaining the standard of general professional knowledge aimed at, then rigid specialisation would have to be resorted to. Unless the Admiralty reserved to themselves the power of detailing any officer to any particular branch, division into permanent diverging branches would leave the provision of officers for any departments that might be less popular at the option of the officers themselves. For this reason the Admiralty reserved to themselves the right of detailing officers for the various branches, but always hoped that the range of attainment would be so wide as to avoid the necessity for permanent specialisation, and that, therefore, there would be no need for compulsory service in any branch.

Now that sufficient experience of the working of the new system has been obtained, it is desirable that definite regulations for future procedure with regard to the allocation of officers to the various branches of the Service should be formulated and promulgated at the earliest possible moment. This question has received earnest consideration, and, so far as concerns those entered under the new system, it has been decided that all executive, engineering, and marine duties will be performed by executive officers of common entry and training, who will specialise for the different duties without separating into permanent and distinct branches. The consequence of this development of the

original proposals is that there will be in future only one class of officer in all departments, and, whether performing engine-room, marine, gunnery, torpedo, or navigation duties, all will be equal and all will be executive officers. Each of these specialist officers will have special knowledge in one particular branch, but all will have a general knowledge of the duties of the other branches, and all will have the opportunities of fitting themselves for the position of captain of a ship, and hence of rising to the highest eminence in their profession. The successful engineer or marine officer will have equal chances, and the same claims to promotion as a successful gunnery or torpedo officer, if his general efficiency is as great; if inefficient he will equally suffer. Special knowledge of engineering or military duties no more debar an officer from obtaining the qualifications necessary to the command of a ship or a squadron than does expert acquaintance with gunnery, torpedo, or navigation, provided that the early training in command and responsibility, which has always been given to officers who undertake the latter duties, is also extended to those who will carry out the former, and provided also that whilst performing specialist duties as lieutenants or commanders all officers are given ample opportunities of maintaining their executive efficiency. There is thus no necessity for the permanent distribution of officers who will undertake ordinary duties in sea-going or harbour ships and establishments into executive, engineer, and marine branches; one class of officer can be instructed so as to perform any of these duties.

Engineer officers.—No fear need exist that the standard of engineering knowledge will be short of that which would have been attained under the previous tentative proposals, since the courses and periods of active practical experience are precisely the same as those which were foreshadowed under the scheme as first propounded, optional reversion to executive duties during the period of commander's service being the sole alteration to the original proposals. Employment in any specialist work should not prevent an officer from gaining the executive knowledge and habit of command necessary for the position of captain of a ship. Experience has shown up to the present that the time spent by an executive or marine officer in the Naval Ordnance or Naval Intelligence Departments of the Admiralty has not unfitted him for his executive or marine duties, and that the time spent by an engineer officer in an Admiralty or dockyard appointment has not rendered him incapable of performing his duties as an engineer afloat. In the same way there is no reason why in future a short term of service at the marine headquarters, or at engineering work ashore or afloat, should incapacitate any officer, who is keen on rising in his profession, from the efficient performance of executive duties. But in order to obtain and maintain such complete interchangeability every facility for maintaining their executive efficiency will be given to specialist officers. Each specialist officer on board ship will be required occasionally to take duty on deck and in the engine-room whilst in the junior part of his service, and to perform the more responsible executive duties as his seniority increases. Every specialist lieutenant must pass the prescribed executive examination for the rank of commander, or else forfeit his claims to any higher executive positions. Further, no officer will be permitted to embark on a specialist course of instruction until he has passed all the examinations for the rank of lieutenant and has served continuously as sub-lieutenant or lieutenant for at least a complete year at sea; he must also have obtained the necessary certificates of competency in watch keeping, &c., from his captain. It will probably be necessary to employ a proportion of specialist officers in their particular specialist work after they are promoted to the rank of commander, in order to obtain experienced officers for special positions. This employment will be regulated in the same way as the present appointments of commanders for navigating duties and of commanders filling special gunnery and torpedo appointments. It is further probable that more officers will desire to continue specialist duties than will be required to fill the appointments in the higher ranks. The Admiralty will thus obtain the power of selection for particular specialist posts in each grade, and at the same time any officer who desires to revert to ordinary executive duties will be able to do so, subject to the sanction of the Admiralty. A proportion of officers will, no doubt, for various reasons, at some period, relinquish hopes of filling the highest executive ranks and commands, and will prefer to continue in the specialist line for which their chief attainments may more particularly fit them.

The following are the detailed arrangements for carrying out the new decision of the Board that there is to be no permanent specialisation of engineer and marine officers.

An officer entered under the new scheme who desires to specialise as a lieutenant for engineering, gunnery, marine duty, navigating, or torpedo, will be called upon to volunteer during the latter part of his service in the rank of sub-lieutenant at sea, and selections will be made annually from amongst those who are recommended. The officers who are selected for the various branches will then be withdrawn from sea service in time to begin the annual courses of instruction, but no officer will begin a specialist course until he is promoted to lieutenant.

The special course of instruction to qualify as engineer officer will include practical and observational work at a dockyard, and also theoretical work and laboratory practice in testing and experimenting. No manual work will be included in this course, as the officers will all have a sufficient knowledge of practical workmanship. On completion of the course and after qualification in the examinations, these officers will become lieutenants (E), and will receive extra pay as such in the same manner as other specialist officers, and will be qualified to perform the duties of a junior engineer officer afloat. In the largest ships only three engineer officers will be required in addition to the warrant officer watch keepers, viz., a commander (E.) or senior lieutenant (E.) as chief engineer, a lieutenant (E.) as senior engineer, and a junior lieutenant (E.) as junior engineer

The system of training of officers for military duties (Lieut. M.) will be based on the probable nature of the work to be done by naval landing parties in war time or when undertaking isolated small expeditions. The course will include a study of the principles governing the attack by ships on coast defences, and on objectives on land or in harbour, and will also combine a sufficient knowledge of Army organisation to ensure efficient co-operation between the two Services in the case of a joint expedition. Of the necessary training about half will be devoted to indoor study and half to practical outdoor work. All duties in connection with musketry and battalion work, with field and machine guns, and also with physical training, will be delegated to the lieutenants (M.) instead of to the lieutenants (G.).

The filling of the higher technical appointments at the Admiralty and dockyards remains for consideration. It is probable that a fair proportion of those officers who go through the (E.) course will be officers who have special aptitude and inclination for engineering work, and who will devote their lives to that particular branch of the Service, and that, consequently, many of them after passing the executive examination for commander, and so qualify for the higher executive ranks, will forego the chance of executive commands afloat in favour of the important administrative positions in the Admiralty and at the dockyards which will be open to officers with high engineering qualifications. It is not possible at the present moment to lay down in detail what the course of instruction for these officers should be, since much depends on the results achieved during the period of qualification for lieutenant (E.), but it is considered that, after passing the examination for lieutenant (E.), a further course of about two years will be necessary to qualify officers for the higher engineering posts at the Admiralty and dockyards, subsequent periods of practical experience at sea being combined with service in the lower grades of these special appointments. At the end of the course for lieutenant (E.), a certain number of officers will be selected to proceed to the further course for lieutenant (E.), and this course should follow immediately after the lieutenant (E.) course. In this way a practically continuous period of instruction will be secured. On the completion of the higher (E.) course these officers will be sent to sea-going ships for a period of at least one year, during which they will perform the duties of an engineer officer; they will then be available either to come on shore to a special appointment if their services are at once required, or to continue to perform the duties of an engineer officer at sea until they are needed to fill a special appointment. After a period of shore service these officers will again go to sea, in either an engineering or an executive capacity, as the Service may require.

One of the three avenues through which the Royal Corps of Naval Constructors is entered, viz., the Royal Naval Engineering College at Keyham, will shortly be closed. It is therefore necessary to widen the existing field of selection for members of this corps. This can best be done by including as candidates young men who have received a thorough grounding in mathematics, science, applied mechanics, &c., and the less advanced practical engineering work, but who may have had no opportunity of practical work at private shipbuilding yards. The restriction hitherto in force as to candidates having been through an apprenticeship in a shipbuilding yard will, therefore, be removed, and private students who enter at Greenwich for the course of training in naval architecture, preparatory to selection for admission as members of the Royal Corps of Naval Constructors, will in future be required to pass an entrance examination in mathematical and mechanical subjects only, or to give evidence of equivalent qualifications, and to show a general acquaintance with practical engineering and mechanical subjects; the necessary shipbuilding and other practical work will be incorporated as a part of the Admiralty course of training. Under these conditions, there should be no difficulty in procuring an ample supply of suitable candidates for the few vacancies that occur.

(2) THE DUTIES OF ENGINE-ROOM WATCHKEEPER AND THE TRAINING OF BOY ARTIFICERS.

The Admiralty have devoted considerable labour to the subject of the provision of a suitable class of man to help the junior engineer officers in engine-room watchkeeping. At present this work is done by engine-room artificers, whose chief attainment is that of a skilled specialised mechanic. While in the Navy he is trained and taught engine-room watchkeeping, which results in considerable loss to the Service of mechanical and repairing talent when a ship is under way.

The engine-room artificer has two distinct functions in a ship at present, viz.:—(*a*) Engine driving; (*b*) use of tools.

Experience has shown that these two duties cannot be performed concurrently, and as there is no certainty that the necessity for the employment of tools will not arise during the period of engine driving, one of the two has to give way. When the ship is at sea engine driving naturally cannot give way, and, therefore, repairs have to be postponed. Hence, when the ship is at sea, the engine-room artificer is prevented by watchkeeping from performing his duties with his tools, and the result is that, instead of repairs being carried out as they become necessary, they have to be allowed to stand over till the ship gets into harbour, and accumulate faster than they can be dealt with. Eventually the dockyard is called upon to make good the surplus defects.

The remedy for this consists in relieving from the general duties of engine driving the artificers who have served a long apprenticeship and whose value lies mainly in the skilled exercise of particular mechanical trades, while at the same time providing that the engine-room watchkeepers shall have sufficient general knowledge of the use of tools and of mechanical work to ensure efficient performance of their duty.

What is wanted of the artificers is the highest class of skill in handicraft, combined with sufficient knowledge of how to drive engines to help them in their repair work. The training of the boy artificers will, therefore, be mainly concentrated on producing a high grade of technical workmen.

The time spent on practical tool work is to be about forty-eight hours per week. Their theoretical training will be mainly confined to the evening, each boy being given not less than two hours' school instruction twice a week throughout the four years of training. The practical training of boy artificers will be directed to the imparting of a high degree of specialist workmanship in one of the three following trades:—Fitter and turner, boilermaker and coppersmith, coupled with a general knowledge of the remaining two of these trades, as well as of those of enginesmith and moulder. Facilities for undertaking larger repair work to the engines of ships and for seeing the larger engineering operations carried out in the dockyard shops will be provided during the latter period of the training of the boy artificer.

The engine-room and stokehold watchkeeping can be performed by men specially selected from the stoker ratings of the fleet, and suitably trained.

As soon as sufficient stoker ratings are qualified for engine-room and stokehold watchkeeping, engine-room artificers will be released from these duties to do the maintenance and repair work, which will in future be chiefly what is required of them.

As regards the stoker ratings, much can be done both to increase emulation and also to afford graduated instruction to keen men of suitable ability during their ordinary work in the engine-room and stokehold.

The selection of men qualified to undertake watchkeeping duties will be made as early as possible, and to facilitate this, a system of gradual instruction throughout the career of the stoker will be introduced. In order to qualify for advancement a candidate will require to have had charge in turn of all the more important classes of auxiliary machinery of a ship, and of the engines of a steamboat, and must obtain a certificate from the chief engineer of his ship as to his satisfactory knowledge of these duties. Leading stokers and eventually mechanians will be selected from the most capable of the trained stoker ratings. The future mechanician will be the watchkeeping chief petty officer, and will have the seniority of command over other chief stoker ratings not so qualified. This substantive rating will carry with it the executive duties of watchkeeper in both engine-room and stokehold.

The existing course of training for mechanician will, therefore, be modified with a view to these requirements, since only sufficient knowledge of tools will be required to ensure that he is able to discharge efficiently his watchkeeping duties. Instruction in workmanship will be limited to the principal trades of fitters and turners; the time saved will be added to that now devoted to practical instruction engine driving and watchkeeping duties.

After qualifying, the men will serve a probationary period of at least six months at sea as acting mechanician, confirmation being subject to the award of a certificate of competency in subordinate watchkeeping duties by the chief engineer officer of the ship. After a further period of sea service mechanicians will be eligible for advancement to the rank of warrant officer, according to ability, after passing an examination in which an educational test will be included.

The same general rules which govern the advancement of the seaman class, whereby fitness rather than rigid periods of service in each rating is considered as the principal qualification for such advancement, will be applied to stoker ratings, so that the more capable of the younger men will rise to warrant rank at the earliest age compatible with the efficiency of the service.

EARL'S COURT EXHIBITION.—It has been arranged to hold in the Earl's Court Exhibition buildings and grounds during the summer session of 1906 an Imperial-Royal Austrian Exhibition. The exhibition has met with strong support from the principal manufacturers and traders of Austria. The Austrian Government have granted a subvention of £20,000 for the organisation of the scheme. The exhibits will embrace within its scope everything appertaining to arts, products, industries and manufactures of Austria.

LEGAL INTELLIGENCE.

REPAIRING A HYDRAULIC LIFT.

At Oxford County-court on November 25th, his Honour Judge Snagge heard legal argument in a case, Tulloch *v.* Waygood and Co., Limited, under the Workmen's Compensation Act, the evidence of which had on a previous occasion been given at Woodstock County-court.

The facts, as proved or admitted, were that Tulloch, a skilled workman, was sent by the respondents, his employers, to Blenheim Palace to examine, and, if necessary, repair a hydraulic lift which was used to carry dishes, &c., from the basement to the serving-room floor, and which was worked by hydraulic pressure acting on a ram to which was attached a pulley for the multiplication of power. For such purpose it was necessary, and, therefore, his duty, to use the mechanical power for the purpose of examining the lift or its mechanism; for adjusting the position of its parts so as to enable him to remedy the defects; and for testing the work when completed. According to the evidence of the engineer at the Palace, who was called for the respondents, Tulloch could not have done his work without using the hydraulic power. Having remedied some defects, the applicant workman proceeded to repair the guides of the cage, and in order to reach the upper guides it was necessary to lower the lift to get on to the top of it through the serving-room door and to stand on a beam between the side of the cage and the wall. Finding that he was not able to reach the guides in this position, he pulled the starting rope to raise the cage a little. It refused to act, and, having taken some measurements of the ram which he required, he proceeded to retrace his steps in order to go downstairs to ascertain what was wrong. Whilst crossing the top of the lift, it suddenly ascended and crushed his head between the cage and a beam. It was contended by Mr. Ellis Hill, instructed by Messrs. Leslie Field, Brownjohn and Co., for the employers, that this was mere plumbing work, and that the definition of "engineering work"—namely, "any other work for the construction, alteration, for the repair of which machinery driven by steam, motor, or other mechanical power is used"—did not apply to these circumstances. It was contended that as the word "work" in that definition had been held to apply to the subject matter of the operation of repair, and not to the operation itself, the machinery driven by mechanical power must be something imported by the contractors for the purpose of the repairing, and could not include such as was part of the thing to be repaired.

On the part of the applicant it was contended by Mr. W. Addington Willis, instructed by Messrs. Spencer, Gibson and Son, that this was engineering work on behalf of engineers by a skilled workman, and that even if it was described as plumbing, that would not take it out of the statute if the conditions of the definitions were found to exist. Secondly, it was urged that the operation fell exactly within the description of the definition, inasmuch as machinery driven by water power was used for the repairing, and that there was no authority for saying that such machinery and power must be imported. So to decide would necessitate the reading of other and qualifying words into the definition. The Scottish case of Reid *v.* Fleming was also cited, which decided that the construction of a hay cutter, in course of which electrical power found on the premises was applied to test the cutter, was "engineering work" within the definition.

His Honour held that the application of the mechanical power was necessary for the purposes of repair, and that the moving of the lift was part of the operation; that the accident had occurred through the mechanical power; and that in his opinion the fact that the machinery and the mechanical power were part of the arrangement to be repaired had nothing to do with the question, and he gave an award in favour of the applicant. Execution was stayed pending appeal.

LAUNCHES AND TRIAL TRIPS.

MOMBASSA, steel screw cargo steamer; built by David and William Henderson and Co., Limited; to the order of Messrs. Maclay and McIntyre, Glasgow; dimensions, 400ft., 50ft. by 28ft. 8in.; engines, triple-expansion, 25in., 41in., 67in. by 48in., pressure 175 lb.; constructed by builders; the mean speed of four runs was 12 knots; trial trip, November 21st.

OCEAN QUEEN, steam trawler; built by Earle's Shipbuilding and Engineering Company; to the order of Mr. John Hollingsworth; dimensions, 135ft., 22ft. 3in. by 12ft. 6in.; engines, triple-expansion, 500 horse-power; launch, November 23rd.

CLAN MACPHERSON, steamer; built by Furness, Withy and Co., Limited; to the order of the Clan Line; a speed of 13 knots was attained; trial trip, November 25th.

CENTURY, steamer; built by Northumberland Shipbuilding Company, Limited; to the order of Furness, Withy and Co., Limited; dimensions, 372ft., 48ft. by 30ft. 10in.; engines, triple-expansion, 25in., 41in., 69in. by 48in., pressure 180 lb.; constructed by Richardsons, Westgarth and Co.; launch, November 27th.

TEESPOOL, "trunk" steamer; built by Ropner and Son; dimensions, 366ft., 53ft. by 30ft. 4in; to carry 7300 tons; engines, triple-expansion, 1850 indicated horse-power, pressure 180 lb.; constructed by Blair and Co., Limited; launch, November 27th.

CLAN MATHESON, first-class cargo steamer; built by Furness, Withy and Co., Limited; to the order of the Clan Line; dimensions, 400ft long and 431,718 cubic feet capacity; engines, triple-expansion, 26in., 43in., 71in. by 48in., pressure 200 lb.; constructed by Richardsons, Westgarth and Co., Limited; launch, November 27th.

ADMIRAL, steel screw coasting steamer; built by Mr. William Walker, of Maryport; to the order of Manchester, Liverpool, and North Wales Steamship Company; dimensions, 121ft., 22ft. by 10ft. 6in.; engines, compound surface-condensing, 15in. and 32in. diameter by 24in., pressure 130 lb.; constructed by Mr. James Ritchie, Partick; launch, November 28th.

KOMURA, turret steamer; built by William Doxford and Sons; to the order of Messrs. Mollwraith, McEachern and Co. Proprietory, Limited; dimensions, 295ft., 40ft. by 22ft.; to carry 3500 tons on 19ft.; constructed by builders; this is the 128th turret steamer afloat; launch, November 28th.

GRACEFIELD, steamer; built by Swan, Hunter and Wigham Richardson, Limited; to the order of Messrs. E. J. Sutton and Co.; dimensions, 321ft. 6in., 46ft. 6in. by 23ft. 11in.; to carry 4600 tons; engines, triple-expansion, 22in., 37in., and 62in. by 42in., pressure 180 lb.; constructed by Swan Hunter and Wigham Richardson, Limited; the engines worked without a hitch; trial trip, November 29th.

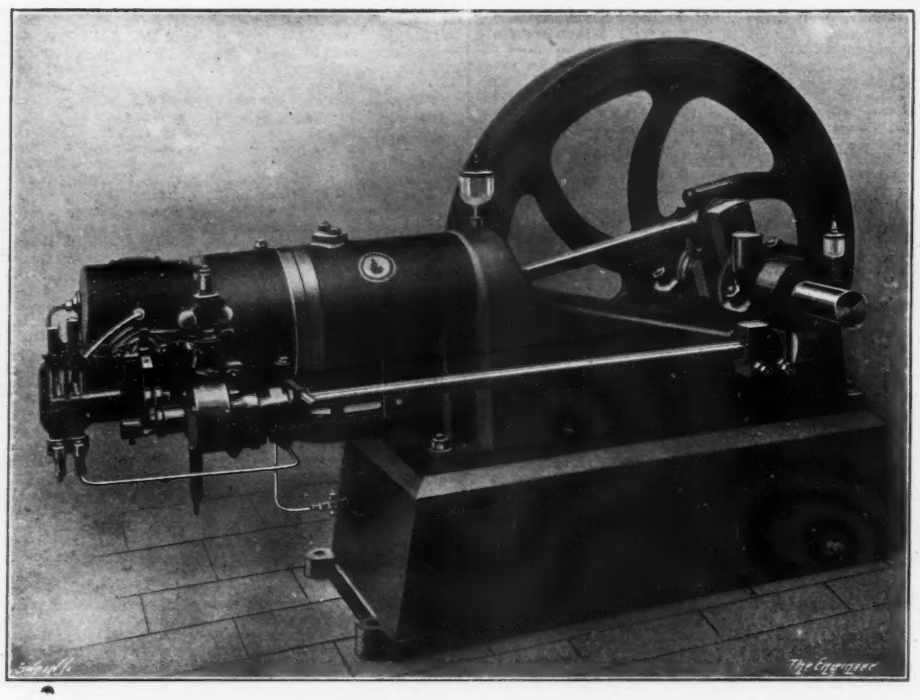
AGGA, steamship; built by Laxevaags Engineering and Shipbuilding Company, Bergen; to the order of Mr. William Hanson, of Bergen; dimensions, 239ft. 6in., 35ft. by 16ft. 10in.; engines, triple-expansion, 16in., 25½in. and 43in. by 30in., pressure 175 lb.; launch, December 1st.

HELIOPOLIS, steel screw cargo steamer; built by Messrs. David and William Henderson and Co., Limited; to the order of Messrs. Harris and Dixon, Limited; dimensions, 404ft., 52ft. 6in. by 29ft. 9in.; engines, triple-expansion, 27in., 4?in., and 73in. by 48in., pressure 200 lb.; constructed by builders; launch, December 1st.

ALBIANA, steel screw steamer; built by Northumberland Shipbuilding Company, Limited; to the order of Furness, Withy and Co., Limited; dimensions, 360ft., 48ft. by 30ft. 10in.; to carry 7250 tons; engines, triple-expansion, 25in., 41in., 69in. by 48in., pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; a speed of 11 knots was easily attained; trial trip, December 2nd.

CRUDE OIL ENGINE

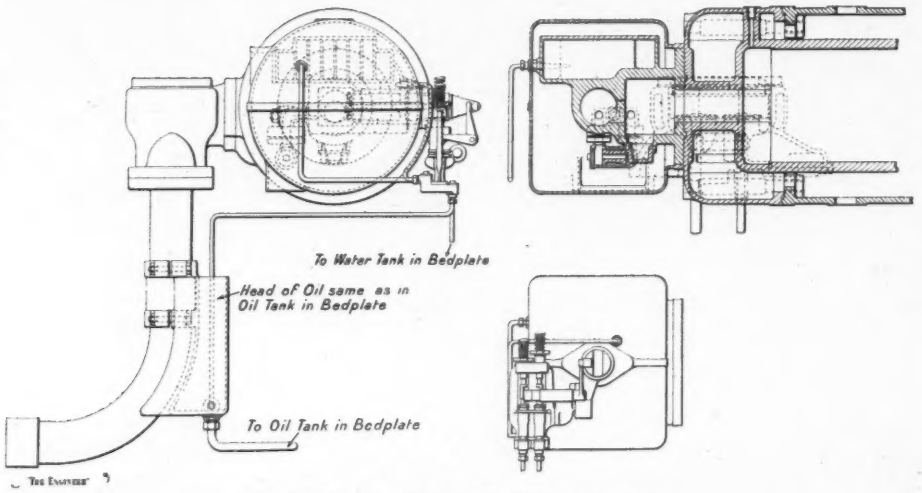
THE BRITANNIA ENGINEERING CO., LIMITED, COLCHESTER, ENGINEERS



CRUDE OIL ENGINE.

In our issue of July 10th, 1903, we fully described and illustrated by sections a new form of oil engine made by the Britannia Engineering Company, Limited, of Colchester, under the patents of Mr. V. Nicholson. The features of principal interest about this engine are the vaporiser and the igniter. The former is a cast iron box mounted on the breach of the cylinder, and provided with baffles, which cause the oil and saturated vapour to take a circuitous path between its heated walls. The igniter is a small cast iron jacket enclosing a cast iron corrugated tube, to which the vapour finds access through suitable openings. This igniter once heated recovers from each explosion of the engine enough heat to maintain it at a temperature sufficiently exalted to fire the rich vapour it contains at the moment of maximum compression.

This engine having proved itself successful with ordinary paraffin, it was decided to make a similar design suitable for crude petroleum. To do this the suction feed, which was satisfactory with thinner oils, has been replaced by a pump feed, and at the same time a pump injecting a small jet of water into the vapour so that high compression may be used is provided. In nearly all other respects the engine remains as before, a slight modification only having been made in the vaporiser to increase its area. A general illustration of the crude oil engine appears above, and sections of the important features are also given.



ELEVATIONS AND SECTION OF CRUDE OIL ENGINE

The pumps are clearly seen in the general view. They are contained in a single casting. The plungers are raised by springs and depressed by a bell crank lever connected, as shown in the end elevation, with the vapour valve. Thus no oil or water is pumped if the governor cuts out a charge. The amount of lift can be regulated by a finger nut at the top of each plunger, and the amount of water and oil delivered with each stroke accurately regulated thereby. The pumps are fitted with ball valves and appear to give no trouble. The oils are so thick that they cannot be pumped cold, and the oil tank is placed as shown on the exhaust pipe in order that the oil may be thinned by warming. Engines, we are informed, using oils with a flash point as high as 250 deg. Fah., have been run for 12½ hours continuously. At the end of this time the igniter was choked and had to be replaced by another, an operation which takes only a few moments to perform, but there was no other trouble.

We have made some simple tests and experiments with several of these engines of different sizes in the makers' works and found that they gave very satisfactory results.

NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

THE surface equipment of the New Goch Gold Mining Company's mine has been entirely remodelled recently, and the consulting engineer, Mr. G. A. Denny, confidently looks forward to an extraction of about 95 per cent., as well as a good reduction in working costs. For the past two years the brothers Denny—H. S. and G.A., the former being general manager of the Albu group of mines—have busied themselves with the introduction of improvements in the reduction and treatment processes of gold extraction. They have, independent of trials conducted by other experts on the Rand, proved the economy resultant on fine grinding, and also shown that the cyanide treatment of "slimes" can be effected continuously, rapidly, and thoroughly, without recourse to the slow settling and decantation process. The slimes, after agitation with cyanide solution, pass to a series of conical tanks in which hydraulic separation automatically takes place, the thick slime passing to the filter presses. At the Van Ryn Gold Mining Company this continuous process has been proved a success, and it is now being installed at the New Goch and the Meyer and Charlton mines. The filter presses that are being put in are of the Dehne type, each press being of five tons dry slime capacity. The press is worked by hydraulic power from an accumulator, and it is estimated that one charge can be worked per hour, so that the six filter presses installed at the New Goch mine may be expected to deal with a total load of 720 tons per day. This is equal to the total output of the 120-stamp battery, estimated at six tons per stamp, so that provision now exists on this mine for a thorough trial of the "all-slime" process. It should be stated that two-stage rock breaking is resorted to previous to the ore reaching the battery, and that two tube mills are being erected to supplement the mill reduction. Another feature of the new equipment at the New Goch is a steel tailings wheel, 55ft. diameter, which is gear driven instead of using the usual belt drive. The two circles of buckets are, as usual, made of wood, but the steel rim to which these are fixed is supported from the hub entirely by tangent spokes, on the same principle as a bicycle wheel. This tailings wheel is working beautifully and in perfect truth.

Murmurs are to be heard to the effect that the promised reduction in working costs of gold mining in the Transvaal has not yet materialised, although the cost of some important mining stores, such as explosives, has materially lessened since the war. Faith in the managements has not, however, declined, and cheaper working costs are regarded as a certainty of the future by those who have carefully weighed all the *pros* and *cons* of the proposition as affected by the conditions under which mining operations have been conducted on these fields during the past two years. There have been outspoken local critics, weak spots have been pointed out, and consulting engineers are now quite on their mettle. A sign of the times is the proposal to abolish the Patents Committee, this being a body of engineers of the highest professional standing, who advise the Chamber of Mines regarding the advisability of opposing applications for patents for processes and appliances connected with the mining industry. Without in any way disparaging the good work that this committee has done, it may be stated that its existence has been to a certain extent a bar to progress. It has never enjoyed the confidence of the large bulk of the mine workers, who, rightly or wrongly, have felt that any invention of probable service locally would be opposed on principle, and remembering the strength of the backing behind the committee, the opposition was likely to be very powerful. Latterly, however, several oppositions have been unsuccessful, internal disagreements are said to have arisen, and the days of the Patents Committee appear to be numbered. There is a wish widely expressed that an advisory Inventions Committee might take its place, to act as a sort of intermediary between an inventor and a combination of mines, so that inventions or suggestions for improvements in mining methods might be submitted for consideration, and recommended if considered promising, recompense for the reformer being naturally one of the objects, as well as a smoothing of and simplification of the introductory procedure.

Practical tests were conducted recently at the Meyer and Charlton Gold Mining Company to prove the power and qualities of a new explosive called "Maganite." In consistency this compound resembles finely crumbled bone, and it is packed in 4 oz.—1¼in. diameter—or 2 oz.—¾in. diameter—cartridges, put up in the usual 50 lb. cases. When loose the powder can be handled without risk, and this was demonstrated by a sample being hammered on an anvil. A red hot iron placed in the middle of an ounce of the compound merely quietly fused it. A sample of the maganite was mixed with gunpowder and fired without dangerous effects. The power of this new explosive was demonstrated below ground in the stopes, where it was used parallel with the usual explosives on both light and heavy cuts. The results of these tests were decidedly promising. At the present time it is merely being manufactured at Capetown in a small way for experimental purposes, but it is stated that it can be produced very cheaply, the selling price of 25s. per case being quoted. If after prolonged practical test underground the power of maganite is found to give as good results as those obtained in these preliminary tests, then this new explosive is bound to become popular, for its safety recommends it, the danger of drilling into mis-fired holes being removed. Another great advantage claimed is that the fumes are signally innocuous, rendering access to the blasted face possible almost immediately after the shots have been fired. It only remains to be said that those present at the tests were very favourably impressed, and there is little doubt of early opportunity being offered for a thorough prolonged trial under ordinary working conditions.

THE IRON AND STEEL INSTITUTE.—The Council of the Iron and Steel Institute have arranged that the annual general meeting of the Institute shall be held in London on May 10th and 11th, 1906. In place of the usual autumn meeting a joint meeting with the American Institute of Mining Engineers will be held in London on July 23rd to 28th. It is intended during the week following to give the American visitors an opportunity of seeing some of the ironmaking districts. It is anticipated that the visiting party will include many of the leading ironmasters who entertained the Iron and Steel Institute in America in 1890 and 1904. The Lord Mayor of London has kindly consented to act as chairman of the London Reception Committee, and to give an evening reception at the Mansion House.

BRADFORD ENGINEERING SOCIETY.—On Monday evening, the 13th inst., at the City of Bradford Technical College, Professor A. L. Mellanby, D.Sc., of Glasgow, read a paper on "Steam Jacketing." The lecturer first drew attention to the difference of opinion that exists among engineers as to the advantages of steam jackets. He showed that from a purely thermodynamic point of view jacketing was useless, but indicated that the usual equation took no account of the "missing quantity," or the difference between the actual steam used by an engine and the amount shown to be in the cylinder by the indicator card. If jacketing is efficient in any case it must be because it reduces this missing quantity. He then described some experiments he had made upon a compound engine at the Manchester School of Technology, and explained that in order to understand why the jackets did alter the efficiency of the engine, the alterations to the horse-power and the steam used per hour must be considered separately. He directed special attention to the following three cases of an engine working at the same pressure, revolutions, vacuum, and cut-off with (1) no jacket on the cylinder; (2) the high-pressure cylinder only jacketed; (3) the high-pressure and low-pressure cylinders jacketed. The effect of applying jackets to the high-pressure cylinder was slightly to reduce the total horse-power of the engine, but when they were applied to both cylinders the horse-power was considerably increased. The increased area of the low-pressure cylinder indicator card was very marked. When working without jackets the air pump discharge was 2184 lb. per hour, but when the jackets were applied to the high-pressure cylinder this was reduced to 1910 lb. per hour. The lecturer then discussed the two main theories that have been brought forward to account for the "missing quantity." He first considered the initial condensation theory, which assumes that the inside skin of the cylinder walls goes through a temperature range approaching that of the working steam. He next referred to the work of Callendar and Nicolson, who found that the cylinder wall had a range of temperature of only a few degrees. He next showed how the condensation could be calculated if the range was known, and pointed out how Callendar and Nicolson found that the initial condensation in engines was much smaller than had hitherto been suspected, and how the valve leakage was, in many engines, a very considerable item. The François engine with jacketed piston was then described, the lecturer mentioning that probably the good efficiency of this engine was due to the fact that the valve chests were completely jacketed, which would go far to reduce valve leakage. The lecture was illustrated by many interesting diagrams which showed graphically the points which the author wished to emphasise.

PROGRESS IN IRON AND IN MECHANICAL ART.*

By J. H. WICKSTEED.

IN treating of progress connected with iron we will first glance at some recent developments, and then endeavour to look back at the earliest records of its use, and trace its slow development through the millenaries which passed from the time of its first use up to the dawn of the nineteenth century, at which epoch, as we shall see, its rate of progress received enormous acceleration owing to the introduction of steam power and power-driven machinery.

It is easy to see that the advance made in iron and mechanical art between the dawn of the last century and the beginning of the present century has been nine or ten times as great in 100 years as it was in the previous 2000 years, but it is more difficult to judge of the rate of progress which is taking place day by day. It might, at first glance, seem to be impossible for us to keep up the rate of advance in the future that was started by the introduction and development of steam power and machinery into a world that had hitherto been without them, for we certainly cannot expect to multiply those marvellous improvements nine or ten-fold.

The proposition about to be put forward in this address is that if during the twentieth century we only double the improvement made during the nineteenth we are keeping up the improved rate of advance, and that if we double the improvement made in the last century in less time than the one hundred years which those improvements took, we shall have accelerated the nineteenth century rate.

For example, let us suppose that after the planing machine was introduced a metal surface of 10 square feet could be trued with the same effort as could a surface of 1ft. square by chipping and filing. That is to say, a century of steam has added to a given effort nine times the efficiency that it had acquired in the whole previous history of iron. Taking this chipping and filing efficiency as one unit, we are entitled to say that if the next century adds another nine units of efficiency to the same effort it will have maintained the rate of improvement established by the last century. That is to say, if the same work which at the beginning of the nineteenth century trued 1ft. can at the end of the twentieth century true 19ft. the twentieth century will have advanced at the same rate as the nineteenth century did. Such an improvement of the machine is not as striking and visible as the first introduction of the machine, but if the iron and machinery of the twentieth century gain as much efficiency as did those of the nineteenth, then we shall again have made as big an advance as was made by the invention and development of machinery in the nineteenth century. A rate of advance is determined by the relation between the time taken and the advance made. If the nineteenth century started with one and finished with ten, it added nine, so that the rate of progress it set was nine units per century.

Success in life largely depends upon our power of estimating new ideas at their true value, and in our own power of imagination to forecast future developments. Let us first, therefore, consider a few of the improvements that are going on around us.

A new departure is being followed before our doors in Leeds of joining tramrails by fusing the ends together with "Thermit," and so making the rail one continuous bar for several miles of length. The object of the plan is that there shall be no gap between the ends of the rails, and no lost motion by vertical movement between the rail ends. When the rails are welded together, any deflection of the end of one rail caused by the weight of the rolling stock equally deflects the end of the oncoming rail and the rolling stock goes over a level surface. The effect of this is to prevent the rail ends wearing down before the rest of the rail.

A similar system was tried some years ago in America by electrically welding the rails together or fusing them together with molten metal, but was not found altogether successful owing greatly to the stronger tendency of the rails to expand under the hot sun of the American summer, and to lift up from their bed. The experiment in Leeds was a bold one, in view of the expansion and contraction of steel between the extremes of temperature in England, but it has now been carried beyond the experimental stage, and it is proved that if the rails are sufficiently well anchored down to their concrete bed the power of the sun's heat upon their exposed surface can be so counteracted by end pressure that it has no effect in lengthening the rail. The rail is free to increase its volume in cross section sufficiently to absorb the summer heat without lengthening; in other words, it may expand and contract in the dimensions of depth and width, but can be mechanically restrained from expansion or contraction in the dimension of length. The improved arrangements for restraining the rails from bowing either sideways or upwards and the success of the Thermit welding, as now put in practice both at Leeds and at Coventry, has led to its introduction even in the hot climate of Ceylon.

Another new departure has been taken experimentally in Leeds with a view to reducing the cost of renewals of the tramway system. Between Shaw-lane and Wood-lane on the Otley-road within the last few weeks a self-moving machine has been at work closing the heads of tram rails on to a girder rail of bulb T section which sits upon the concrete foundation, and which is anchored down and cross-tied in the ordinary manner. The girder rails are fished much in the ordinary way, but the head rails break joint with the girder rails below, and it may therefore be expected to afford smooth running, as the ends of the head rail cannot dip or lift one below the other so as to be subject to a hammering action from the rolling stock, and when the head rails are evenly worn down by legitimate rolling friction and require replacing, the self-moving machine strips the head rail off the girder rail and lays on the new head rail at very small cost in comparison to uprooting the rail from the concrete and renewing the whole section throughout.

Concurrently with these inventions, and having the same object in view, namely, that of increasing the life of the rail under incessant traffic, a process has lately been imported into England called the "McKenna" process, which consists in rolling rails at a very dull heat. This process appears to toughen the metal and increase its powers of endurance under rolling stock. The process would be easy of application to the heads of the compound rail already described. Railway wagons are now made in Leeds on under frames of solid flanged plates pressed hot in a press 45ft. long. The weight of these frames is about 17½ per cent. less than that of frames built up from rolled sections.

In Wakefield, ships' boats are made of welded steel. Each half of the boat is pressed into shape hot, and then the two halves are welded together along the keel from stem to stern. The welding is so easily done that a possible development suggests itself to the writer. Why should not a ship's hull be made by welding the plates in position? The blow pipes would be both inside and outside the hull, and duplex hammers would synchronise in striking the weld. A smooth hull would present the minimum of frictional resistance in the water, and much weight in overlapping plates or butt straps and in rivets would be saved.

It is gratifying to note that the manufacture of copper tubes and jackets by electrical deposition, accompanied by burnishing at every layer with flat pieces of agate held in wooden clamps, invented a good many years ago by Mr. Elmore, has now been brought to practical perfection. The invention of Mr. Elmore consisted in burnishing the particles of copper as fast as they are deposited by pressure from pieces of agate constantly traversing to and fro along the length of the tube. By this means tubes of any thickness, or copper plating of any thinness, can be carried out, and the process is entirely successful if it is carried out continuously from start to finish. This condition implies that the central power station be kept running night and day without a break.

The writer, wishing to coat a hydraulic ram for a large testing machine with a material that would give no trouble from rust, had it covered with a deposit of copper ¼in. thick laid on by the "Elmore" process at the Leeds Copper Works. The ram was 2ft. diameter and 9ft. long. The pressure in the hydraulic cylinder of this ram went up to one ton per inch, yet it gave no trouble by entering between the copper plating and the cast iron ram, which it would have done unless the cohesion of the copper to the cast iron had been complete as to every particle.

Within a few days the writer was privileged to see the development in Leeds of the De Laval turbine. It is being made over a very large range of powers, from 5 horse-power up to 500 horse-power. Members will be aware that this turbine revolves at 10,000 to 30,000 revolutions a minute, and does its work through double helical reducing gear. If used for more than small powers, as for generating electricity, the form that it takes is for the turbine pinion to work between two wheels, each on the end of a generator spindle, thus the one turbine drives a pair of generators, and the pinion on the turbine shaft runs in equilibrium of pressure between the pair of wheels. Members will easily understand that at the enormous velocities of this gearing the slightest variation in the pitch of the teeth would make itself felt in noise and in wear, and the necessary exactness of pitch has only been attained by the labour of brain and hand for two years in accurately dividing a master wheel. The system of balancing the turbine wheel on its slim spindle, and also the construction of the governor which regulates its speed, are much to be admired.

Any members who have followed the proceedings of the Iron and Steel Institute will remember a paper, given by M. Harmet, of Saint Etienne, on "The Compression of Steel during Solidification in the Ingot Mould, to avoid the Effects due to Free Shrinkage." The process is easily explained. The ingot mould has a movable bottom, which is pushed up as fast as the molten ingot contracts in cooling. Thus the sides of the ingot are pressed against the tapering sides of the mould, and are thereby squeezed inwards, which prevents the ingot from forming cavities in the centre through contraction, and which also, by more rapid cooling, prevents the liquation of carbon in the fluid metal.

Although this paper was only read three years ago, the invention has been taken up both in Leeds, in Sheffield, and in Glasgow.

The process seems to be akin to Sir Joseph Whitworth's invention, which he applied particularly to tubular ingots from which to forge hollow shafts, gun tubes, cylinder linings, &c. &c. Sir Joseph Whitworth read a paper explaining his process, in 1875, before the Institution of Mechanical Engineers' meeting in Manchester, and the writer well remembers listening to that paper and the discussion which followed, in which Sir Wm. Siemens, Mr. John Ramsbottom, and Mr. Daniel Adamson took a leading part. Sir Joseph Whitworth lined his ingot moulds with sand, behind which there were grooves in the construction of the moulding-box in order that all gas might escape from the molten metal. The pressure was raised to 6 tons to the inch. The process was entirely successful for his purpose. He even applied a pressure of 20 tons per inch, and found that with that amount of pressure the fluid-compressed steel was rendered so perfect that it could not afterwards be improved by any process whatever, and needed no forging for any purpose.

In the Harmet process there is no refractory lining, but the ingot is brought into immediate contact with the metal of the moulding-box. There is no pressure upon the ingot, but the solidifying portion and the spongy portion is squeezed inwards, as in wire-drawing, so as to allow no cavity whatever for gases, or for vacuum through contraction, between the solidifying shell and the fluid centre of the ingot.

The writer's firm have made a lathe spindle from steel cast by this process and afterwards forged and oil-hardened for a large lathe. This spindle was 27in. diameter over the collars and 10ft. long, and carries a load of about 50 tons on the front neck.

Concurrently with this improvement in the casting of steel ingots great improvements have been made, not only in the chemical composition of the steel itself, but also in its thermal treatment, after it has been forged into the article required. A 6½in. thick armour plate of to-day is as strong to resist the attack of a projectile as was armour plate 15in. thick when it was made of unalloyed iron.

None of these improvements are more wonderful than those by which steel for cutting tools has been made, so that it will actually preserve a cutting edge hard enough to take heavy cuttings off ordinary steel and iron when it has become almost red hot. The consequence is that the speed at which machine tools, such as lathes, planing machines, and drilling machines, can be worked is quite doubled. This has only been accomplished in the present century. Before the year of the Paris Exhibition in 1900, it was thought good work to drill a 1in. diameter hole through a 1in. thick steel plate in one minute. It is now just as practicable to drill the same sized hole through 2in. thick in one minute. It is, however, done at the expense of heat. The reason it can be done is because the new steel keeps a hard edge at a temperature which would have softened former steels. It is wonderful to see a tool glowing with a dull red colour turning off heavy cuttings blue hot from a steel forging at the rate of 60ft. cutting speed per minute, the cutting being ½in. deep and ½in. thick, and this to go on for six hours without relieving the tool. Still more wonderful feats can be performed with this steel for short runs, a 1in. diameter hole can be drilled through 12in. of cast iron in one minute, but there is an objection to developing too much heat in any hole which requires to be very smooth and true as the drill leaves it, and for this and other reasons it is enough to say that the improved steel will cut at double the speed that could be used up to the end of the nineteenth century.

In the nineteenth century 20ft. a minute was regarded as a good standard rate of cutting for a planing machine. To-day 40ft. a minute may be considered the standard. If planing machines cut on both strokes, doubling the speed of cut would double the work done in a given time; but if the machine has an idle return stroke, it is necessary to double the speed of the idle return stroke as well as that of the cutting stroke in order to attain a 2 to 1 improvement. A 3 to 1 ratio of quick return was considered good when the cutting stroke was at 20ft., and this gave a return speed of 60ft. To make a 2 to 1 improvement you must not only double the cutting speed, but you must preserve the ratio of 3 to 1, which doubles also the idle return speed and brings it to 120ft. per minute.

There is no difficulty in accomplishing this with a sufficiently powerful drive, and the high initial speed of electric motors facilitates obtaining sufficient belt velocity to give a quick return speed satisfactorily. The time lost in an idle return stroke of a planing machine, however, can be saved by making it cut on both strokes. This was recognised by Sir Joseph Whitworth before any of us were born, and he devised a semi-revolving tool holder which presented the cutting face in one direction for the inward stroke of the table, and, turning half round automatically at the reversal of the machine, presented the same cutting face to the outward stroke of the table, and thus saved all lost time during the working of the machine. The principle has been adopted by many makers of plate edge planing machines for planing ships' plates, boiler plates, and girder plates. The work, however, for which this form of double cutting is most suitable is only plane surfaces, as it is necessary that the work should give room for the tool to turn rightabout-face at each end of the cut.

When the work is of such a shape as not to give space for the tool to turn round, the drawback to this holder is that it is not adapted for cutting on one stroke only, because it does not relieve itself, and being rigidly held would lose its edge on the return stroke if cutting in one direction only. Many inventors since Sir Joseph Whitworth have attempted to design double cutting tool boxes more adapted for general use, but, probably, the most successful system developed during the nineteenth century was that of having two complete sets of tool boxes on independent cross slides and uprights constructed to face each other, and thus hold tools in self-relieving tool boxes, facing the work in opposite directions. This plan has been applied for planing the faces of armour plates where each cross slide has carried as many as eleven cutting tools, and this makes a highly efficient machine for such a special purpose.

The writer presented a paper to the Leeds University Engineering Society some years ago in which he reviewed all the then existing methods of cutting on both strokes, including a design of his own. In analysing the advantages of all the designs and assigning marks of merit to them, with 12 for the maximum, he could not at that time credit any of these boxes with more than 11 marks. The full marks were four, under each of the following heads:—Self-relief, facility of adjustment, accessibility. But the double-cutting tool box which he has perfected since that date has all the convenience and stability of construction of a good single-cutting tool box, and gives the advantages of double-cutting, when required, as well. When single-cutting is necessary this tool box is just as convenient as an ordinary single-cutting box, and, under his former system of judgment, would obtain the full possible number of marks. It is however, obvious that in some cases, as, for example, in planing valve faces inside a steam chest, there is only room for a single tool to enter the chest and start from a landing at one side of the valve seats, whilst it finishes at a landing on the other side, and in such a case one tool only can be used.

It needs no more than stating that in all work that is clear of projections close up to the planed part, the saving of time in a double-cutting machine is 25 per cent. on the time taken for the same work on a machine with a quick idle stroke, having a speed ratio of 3 to 1 on the cutting stroke; but it should be explained that if a machine with an equal return stroke is working for only half its time double-cutting, and half its time single-cutting, it will still do as much work as a 3 to 1 quick-return machine which is single-cutting through. Suppose you have such a quick-return machine working for 120 hours. It will be cutting for 90 hours, and returning idle for 30 hours. It will do 90 units of work in 120 units of time; but so will a machine with equal return stroke, if two-thirds of the work permits of double-cutting, and one-third has to be cut with a single tool. For if this equal return machine be working for 120 hours, and cutting half its time on both strokes, and half its time on one stroke only, then in the first half it will be cutting for 60 hours, and in the second half cutting for 30 hours and idling for 30 hours, and it, like the quick-return machine, will do 90 units of work in 120 units of time. Thus it is equal in output to the quick-return machine, if it works half its time double cutting, and it begins to gain upon the quick-return machine as soon as it is employed for a larger fraction than half in double cutting, and when it has reached full time double cutting it has gained 25 per cent.

It will be a revelation to many to see from this simple arithmetic that it is no bar to the advantages of double cutting on a planing machine that there may be many jobs which do not permit of the use of both the tools. On the contrary, the statement which you have just followed will make it clear to you, once for all, that even if one-third of your work is better planed with one tool, you only lose the same amount of time by foregoing the quick return in doing that portion of the work without a quick return as you gain by double cutting on the other two-thirds of the work.

Perhaps there is no question connected with machinery that is of more interest than that of friction. The experiments made by the late Mr. Beauchamp Tower on behalf of the Institution of Mechanical Engineers upon lubricated friction showed that a journal, with bath lubrication self-induced under the seat of pressure, had a coefficient of friction of 1 in 1000, and that it can with the same coefficient at from 20 to 200 revolutions per minute; but that a footstep bearing, with self-induced lubrication from the centre, had a coefficient of 1 in 100, and that whenever the coefficient of friction exceeded 1 in 100, some wearing and heating of the metal surfaces was taking place.

The experiments also demonstrated that a journal with self-induced lubrication would carry about 450 lb. of load continuously per square inch of diametrical section, and that a footstep bearing, with lubricant flowing into the centre of the step by gravity and discharged by centrifugal action, would carry about 150 lb. continuously per square inch of surface. If you desire to support a greater load per square inch than these that have been mentioned, you must have recourse to forced lubrication. This is now carried out in footstep bearings up to pressures as high as one ton to the inch.

The long turbine shafts at the Niagara Falls power station are supported on this principle, and revolve on a water pivot under pressure.

The Curtis turbine, which is constructed on a vertical shaft, and which is made with as much as 75 tons of revolving weight, revolves upon a hydraulic footstep bearing, and the whole weight is entirely water borne. The coefficient of friction must be extremely small, as these turbines will continue running for five hours after the steam is shut off, and it is easy to turn a 2000 horse-power turbine round by hand. The footstep bearing lends itself to forced lubrication under high pressure better than a journal. So long as self-induced lubrication, or lubrication mechanically circulated at a low pressure, was used, the journal would carry, as we have seen, three times the weight per inch of effective bearing that a footstep or collar bearing could do. But with the hydraulic pivot the footstep bearing can be made to carry any desired load without appreciable friction. The writer's firm have lately used such bearings for taking up the end thrust of worm shafts running at a high speed under a load of 25 tons.

Reverting to bearings working with self-induced lubrication, the writer has seen at the Worcester Technical Schools, Massachusetts, a journal 6in. diameter, 6in. long, revolving on a horizontal axis, lubricated, and, in fact, borne by a self-induced film of air. The coefficient of friction was only 1 in 10,000, and the pressure on the film was only about 21 ounces per square inch measured, not circumferentially, but on the diameter and length of the bearing. The journal was run up to 4400 revolutions per minute.

Professor Albert Kingsbury originated this lubricated bearing, but the writer is unable to inform you to what further load it might be successful beyond that which has already been published by Professor Kingsbury.

The foregoing remarks upon the friction of lubricated bearings refer to bearings running at high speeds, but if the speeds of a rubbing contact between the surfaces are sufficiently low, and the surfaces sufficiently hard to resist abrasion, it appears to the writer that bearings will work under very high pressure without any lubricant at all. The writer has had an interesting experience in this direction in the use of a chain.

A pair of commom short-link chains of ¾in. iron were used in a slotting machine to carry a saddle weighing 25 cwt. at one end and a balance weight weighing 25 cwt. at the other end. The chains passed over pulleys forty times the diameter of the iron, yet these chains cut their links through and broke after twelve months' use; there was plenty of grease smeared upon the chains, but as they were never relieved from the load, it is probable that no grease found its way under the seat of pressure. Every time the links took a curve over the pulley, and every time they changed from a curved line to a straight line in coming off the pulley, there would be a rubbing action between the links, and it is roughly calculated that after the links had endured about 1,000,000 of these rubs they were worn through. These chains were replaced by new ones on which no grease was smeared, but which were thoroughly case-hardened, and after three times the length of service and, by estimation, 3,000,000 rubbing movements, no perceptible wear or deterioration has been found between the links. The fact is that the case-hardened material is too hard to bite under the same load which made the soft material bite, probably from the very first movement made under pressure between the links, and the days of the chain were numbered from the commencement.

The hardened chain did not bite, and as no measurable wear has

* Institution of Civil Engineers: Association of Yorkshire Students. Lecture delivered at Leeds, November 16th, 1905.

yet taken place, the measure of its days cannot yet be numbered. The coefficient of friction has not yet been measured between these hard metallic surfaces, but the knife edges of scales made of agate or of testing machines made of very hard steel do not appear to present a higher coefficient of friction than 1 in 10,000.

From all this we may infer that when a bearing is entirely oil borne or water borne, or air borne, the surface speed and the quality of the metal is almost immaterial, as there is no metallic contact, but that whenever any failure of the film of fluid occurs the nature of the metals that come in contact makes all the difference between siezing and rubbing each other away or enduring for a short time or at slow speeds without abrasion.

From these few instances one may see how mechanical art is bringing about many two to one improvements in the direction of the endurance of iron suitably treated, the speed with which it can be tooled, and the economy of power in cooling it. Let us now see how long it took to make a two to one improvement before the era of steam power and machinery, and for this purpose we will follow the single line of iron and iron chains.

There is every reason to suppose that in countries where iron ore existed on the surface the knowledge of iron would be primeval. We only need to pre-suppose the possession of fire, and then imagine someone leaving a grid made of sticks daubed with red or brown hematite ore a few hours in a charcoal fire, and the result would be a lump of malleable steely iron in the embers. We can, therefore, assign no date to the first knowledge of iron; but in the earliest hieroglyphics to which an accurate date can be fixed—namely, in the fourth millennium B.C., we find Pyramid texts which prove beyond question that iron was well known in Egypt at that time, and that it was forged into weapons, tools, and instruments. After an obscure existence of 3000 years from the assigned date of the Pyramid test, iron became historically famous.

(To be continued.)

THE BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.—Mr. Baldwin Latham, M. Inst. C.E., will read a duper dealing with a case of lead poisoning which recently occurred in the South of England, at the winter meeting of this Association, to be held on December 16th.

THE Audley Engineering Company, of Newport, Salop, has secured a contract from the South Australian Government for the supply of plans and machinery for, and general laying out of, a large vertical cast iron pipe foundry—an addition to their present large foundry and engineering works.

JUNIOR INSTITUTION OF ENGINEERS.—A meeting will be held on Friday, 15th December, at 8 p.m., at the Westminster Palace Hotel, when a paper on "Electric Mains for Power Transmission Work," by Professor John T. Morris, M.I.E.E., Member, will be read. Saturday morning, 16th December, at 10 a.m., a visit will be paid to the electrical engineering works of Messrs. Johnson and Phillips, Old Charlton.

INSTITUTION OF CIVIL ENGINEERS—GLASGOW ASSOCIATION OF STUDENTS.—At a meeting of this body held on the 4th inst. in the Institution Rooms, Bath-street, Glasgow, Mr. D. A. Matheson, M. Inst. C.E., presiding, a paper on the "Construction of Main Sewers under Railways on Glasgow Main Drainage Works," was read by Messrs. A. L. Houston and R. M. Morton, Studs. Inst. C.E. The paper dealt with four typical crossings under railways for which different methods were employed to suit local circumstances. These embraced the construction of sewers in open cut, in a simple driven tunnel, and in an iron tunnel driven by means of a hooded shield and compressed air. The last-mentioned method, which was used for constructing the main sewer under the Queen's Dock sidings, was considered by the authors as the most adaptable for crossing under railways. Messrs. R. D. Brown and A. Turner, Studs. Inst. C.E., also described some portions of the Glasgow Main Drainage Works. An interesting discussion followed.

BATTERSEA POLYTECHNIC ENGINEERING SOCIETY.—The opening meeting took place on Saturday evening last, December 2nd, when Professor Unwin, F.R.S., who has accepted the position of President for the session, delivered an address on "Harnessing Niagara," the address being illustrated with lantern slides. The chair at the opening of the meeting was taken by Sir W. H. White, K.C.B., F.R.S., the retiring president, to whom a vote of thanks for his services was proposed by Mr. Glegg, Mayor of Wandsworth, and a member of the governing body, and seconded by Mr. C. L. Simpson, of Messrs. Simpson and Co., Limited, Pimlico, both these gentlemen being past-presidents of the Society. The meeting was very largely attended, the lecture room being crowded, many of the audience standing during the whole time. At the close of the address a vote of thanks to Professor Unwin was moved, by Sir William White, and seconded by Principal Wells.

THE INSTITUTION OF CIVIL ENGINEERS — ASSOCIATION OF YORKSHIRE STUDENTS.—The opening meeting of the above Association was held in the Law Institute, Leeds, on Thursday, November 16th, when the president, Mr. J. Hartley Wicksteed, M. Inst. C.E., past-president I. Mech. E., delivered his inaugural address, the subject being "Progress in Iron and in Mechanical Art," which is printed above. Mr. Wicksteed dealt with the developments in various branches of mechanical art that had been achieved in the past, and the amount of improvement that would be necessary during the present century to maintain a similar rate of progress. The address was illustrated by lantern slides. At the conclusion a hearty vote of thanks was accorded to the president for his address, on the motion of Mr. Ewing Matheson, supported by Professor Goodman and Mr. W. J. Cudworth.

STEEL BARREL WORKS.—At the invitation of the directors, a large number of engineers and other gentlemen inspected the new works of the Steel Barrel Company, at Uxbridge. This firm has now carried on business at Uxbridge for nearly six years, and the increasing demand for its manufactures necessitated the construction of new buildings. The new works are situated at Phœnix Wharf—not far from the old works. The building, which is of corrugated iron, measures 300ft. by 160ft. wide. It is suitably divided and arranged so that raw material entering at one end of the shop passes out at the other end in a finished state. The power house is 50ft. by 50ft., and contains a high-speed Belliss and Morcom engine of about 280 horse-power. It is coupled direct to a large "Johnson Lundell" dynamo, built by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne. This firm also supplied the switchboard and all the motors that are used for driving the machinery. In the power house there is also a small Gwynne's high-speed engine driving a centrifugal fan, which is used for the Ledwards condenser. The boiler-house is particularly large. It is 60ft. by 60ft., and contains one Lancashire boiler—30ft. by 8ft., made by Messrs. Daniel Adamson and Co. The working pressure is 120 lb. per square inch and forced draught is used. A superheater is also fitted. The shaft, which is of novel construction, was made by the Steel Barrel Company at its old works. It is 53ft. in height and is all in one piece, the different plates having been welded together electrically. It was brought to Phœnix Wharf in a barge, and only took two hours to erect. All the machinery is driven by electric motors, with the exception of the machine for rolling the plates, for making the barrels into their correct shape, and this is connected through gearing to a two-cylinder steam engine. Most of the machinery is made by Messrs. Scrivener and Co., of Leeds. The main feature in the construction of the barrels and tanks is the electric welding, and in the new works a large plant has been erected for this purpose. The results obtained with this system are said to have given every satisfaction, and the strength of the barrels and tanks is increased considerably. A separate building has been erected for the offices in close proximity to the works.

END OF THE COAL DISCUSSION IN WALES.

THE long-protracted discussion between coal owners and workmen in Monmouthshire and South Wales ended, as was anticipated, amicably on Saturday last. The agreement is practically a renewal of the old, with a few minor alterations. At some stages of the conference a crisis was narrowly avoided, and for a few hours on Saturday the situation was doubtful. Happily, all has ended well, and as the arrangement has been brought about fully three weeks before the expiration of the existing agreement, the effect upon the labour market will be tranquilising, and outsiders fully expect that it will do much to improve the depressed condition of things.

Eliminating the opinions expressed *pro* and *con.*, and the salient points of the discussion on both sides, the formal agreement as certified by the joint secretaries is as follows:—

"MEMORANDUM OF AGREEMENT.

"The owners, after careful consideration, whilst reiterating their contention that they are entitled to some relief to meet the position arising from the selling price being below the equivalent to the 30 per cent. rate of wages, and regretting the inability of the workmen's representatives to see their way to meet the owners' alternative proposals, for reduction of the minimum, or the raising of the equivalent selling price, on the special clause submitted by the owners, the owners now decide that they must leave it to time further to prove their contention for the necessity of relief; and having regard to the general interests of the whole trade of this district, have decided to agree to the final proposals of the workmen's representatives, which are briefly as follows:—

"(1) That the evidence as to the selling price of large coal shall be confined to the price of large coal *delivered* f.o.b.

"(2) That there shall be twelve days' holidays for the workmen in each year, such holidays to include the miners' demonstration day, and the dates of the holidays to be agreed upon by the Joint Board. At the few collieries where Mabon's day now exists that custom shall be abolished forthwith.

"(3) That the haulers' wages, with a view of considering a re-arrangement, shall be dealt with by the joint Board at a convenient date.

"(4) That the term of the agreement shall be four years from the 1st of January, 1906, and thenceforward terminable by three months' notice at any time.

"(5) Other alterations and clauses, which have already been mutually agreed upon in the present agreement, to be included in the new agreement.

"(6) The clauses in the existing agreement necessitating alterations to be re-drafted by a sub-committee of owners and workmen's representatives, who shall submit the same to a further joint Board meeting to be held on the 11th instant from the signing of the new agreement

"Signed F. L. DAVIS,
"On behalf of the owners' representatives.
"W. ABRAHAM,
"On behalf of the workmen's representatives.
"W. GASCOYNE DALZIEL, } Joint secretaries."
"THOMAS RICHARDS, }

It will be seen that the only amendment of importance which the owners have secured is the insertion of the word "delivered," which means that the average selling price to be ascertained is the coal delivered, and not, as previously stated, "sold." The workmen have abandoned the increase of minimum to 35 per cent.; the abolition of maximum of 60 per cent.; the payment for small coal; the appointment of umpires in local disputes; recognition of only unionists by the federation; and weekly instead of fortnightly pay.

The coalowners also withdrew these proposals:—Reduction of the equivalent selling price; half-yearly instead of quarterly meetings for alteration of wages; reduction of the Conciliation Board from 48 to 24 members; and increased payment for house coal by colliers of 3d. per ton for every 5 per cent. rise in wages.

INCREASED RAILWAY FACILITIES FOR COAL TRADE.

PERHAPS no enterprise of modern times has been equal to that of the development of the South Yorkshire and Derbyshire coalfield, and the extension of various railways in order to place the pits, so to speak, in almost direct communication with the metropolis and the seaboard. Year by year parliamentary powers are sought for the construction or the development of new railways, so that new collieries, isolated, as it were, from the industrial world, are placed in an advantageous position as regards railway communication. The development of the Derbyshire and Notts coalfield has of late years received marked attention from railway companies, whilst the tapping of what may be termed the new South Yorkshire coalfield, wide of Doncaster and Rotherham and extending as far as Maltby, is being specially catered for. One of the most important events of the year connected with the coal trade is the acquirement of the Lancashire, Derbyshire and East Coast Railway by the Great Central Railway Company. The opening of the newly-acquired railway placed it in communication with some of the largest collieries in Derbyshire and Notts—amounting, it was estimated at the time, to a daily output of, in round numbers, 37,000 tons, equal to about 11,000,000 tons per annum. A large number of other collieries are within easy reach of the line. The Great Central, it is stated, contemplates a still further larger extension of the coal traffic by the completion of at least five easy junctions between the lines of the cross-country railways and its own trunk system. The coalowners in the Bolsover and Shirecaks district will be benefited by having more direct access to the port of Grimsby. The South Yorkshire coalowners have no cause to complain, for, by the vast network of branches, the Hull and Barnsley Railway Company is fed with a large tonnage of coal.

The coming session of Parliament will be called upon to deal with a number of Bills having for their object the construction of new lines and the acquirement of land near new collieries. The Great Northern or the Great Central ask for powers to construct a new railway at Hampole by a junction with the West Riding and Grimsby Railway, terminating in the township of Hooton Pagnell by a junction with the South Yorkshire Extension Railway of the Hull and Barnsley, near Moorside Station. The South Yorkshire Joint Lines Committee ask for powers to construct a new line, to be called the Maltby Colliery Branch. The line will commence by a junction No. 7, authorised by the North-Eastern Act, 1902, terminating in the parish of Maltby, where the Sheepbridge Coal and Iron Company are sinking a large new colliery, where 8000 acres of coal have been acquired, and 2000 acres more are available.

CATALOGUES.

W. H. BAILEY AND CO., Limited, Salford.—Circular on Bailey's gyrometers or "Sight" speed indicators.

C. L'ESTRANGE EWEN, 45, Hope-street, Glasgow.—Second edition of catalogue of internal combustion motors and motor boats.

LANCASTER AND TONGE, Limited, Pendleton.—A pamphlet from this firm contains a description of the Lancaster metallic packings, and list of users

MIDLAND MANUFACTURING COMPANY, Limited, Celtic Works, Sheffield.—This little book is devoted to screwing tackle, engineers' and pipe-fitting tools.

KITSON LIGHT FOREIGN SUPPLY COMPANY, 100, St. Martin's-lane, London.—A small pamphlet sent us gives instructions to be observed in the use of the "Empire" lamp.

THOMAS SMITH AND SONS, of Saltley, Limited, Birmingham.—A catalogue recently issued by this firm deals entirely with drop forgings, the variety of which is remarkable.

A. WARDEN AND CO., 60, Great Eastern-street, London, E.C.—This circular illustrates and describes the "Lytestrong" patent pressed-steel split pulley, which is about half the weight of a cast iron pulley of equal size.

R. AND J. BECK, Limited, 68, Cornhill, London, E.C.—This catalogue is devoted to telescopes, spectroscopes, and surveying instruments. We are requested to state that copies will be sent to readers of THE ENGINEER on application.

GILBERT ARC LAMP COMPANY, Limited, Chingford, Essex.—New arc lamp catalogue. This contains particulars of every type of arc lamp and accessories made by this firm. The book is neatly produced, well illustrated and indexed.

BAKER'S PATENT APPLIANCES COMPANY, Limited, Scarborough.—The Baker oil separator, in its numerous patterns, takes up the bulk of this catalogue. Illustrations are, however, included of steam and electrically driven oil pumps for use with the Baker separators.

MATTHEWS AND YATES, Limited, Swinton, Manchester.—It was a happy idea on the part of this firm to combine the unobtrusive advertising of Cyclone fans with important extracts from the Factory and Workshop Act, 1905. This has been done in the form of a neat wall sheet.

NORTON AND GREGORY, Limited, Castle-lane, Buckingham-gate, S.W.—A booklet sent us deals with "Velography," the latest method of reproducing tracings. It is claimed that copies by this process, being printed in ink, are as permanent as an original drawing.

MATHER AND PLATT, Limited, Manchester.—We have received a copy of Messrs. Mather and Platt's two-cycle gas-engine catalogue, fourth edition, which is fresh from the press, and contains numerous photographic representations of engines of unusual dimensions constructed on the two-cycle principle.

THOMAS PARKER, Limited, Wolverhampton.—Circulars 1A and 2B, just received, contain respectively specifications of belt-driven multipolar dynamos and continuous-current motors. The dynamo is of the standard four-pole type, and the motors are of the "C" type, and enclosed with four poles.

FRANK PEARN AND CO., Limited, West Gorton, Manchester.—This is a sectional catalogue, dealing with boiler-feed steam pumps, such as the Cameron, double-acting, quadruple-acting, and other types. The numerous illustrations include very clear sectional views of the Pearn single-acting ram pump, and the firm's method of packing ram pumps.

W. G. BAGNALL, Limited, Stafford.—The 10th edition of this firm's catalogue dealing with locomotives, railway rolling stock, &c., is produced in an attractive fashion. The contents cover practically the whole field of railway work as regards permanent way and rolling materials. With two exceptions the illustrations are very good.

JONES AND HORSFIELD, Denton, Manchester.—The boiler and steam pipe covering described in this pamphlet is a mechanical contrivance, substantial in quality, and can easily be removed in any part and refixed without detriment, at small cost. It will not burn away or carbonise, and is not affected by expansion and contraction.

THOS. AND WM. SMITH, Limited, Newcastle-on-Tyne.—In introducing this handsome catalogue, the firm have endeavoured to show as many illustrations as practicable of the uses to which wire ropes can be put, and, what is more essential, have included a vast amount of useful information regarding the breaking strain, weights, &c., of these ropes. The illustrations are of a high quality.

WILLIAM KENYON AND SONS, Dukinfield, Manchester.—The new edition of this useful publication, entitled "Epitome of Lectures on the Transmission of Power by Ropes," contains the subjects of addresses delivered at many technical institutions and before the leading engineering societies in the United Kingdom. In this edition the publishers have sought to present not only the essence of their own progressive efforts, embodying personal experiences of American and continental as well as home practice, but they have also incorporated the gist of other expert evidence upon the subject, elicited during those instructive discussions which invariably follow the lectures.

CHARLES WINN AND CO., St. Thomas Works, Granville-street, Birmingham.—Boiler mountings and engine fittings are the subject of a new catalogue, D 38. Attention is drawn to an improved parallel slide stop valve, in which are employed, in combination with other parts, a pair of wedges and a spring. The latter is fitted in a casing in the usual manner, and two hollow rectangular wedges are hung loosely upon the casing, one on either side of the main spindle. The wedges in no way interfere with the free opening and closing of the valve, as they only come into operation when the bore of the valve is closed, and operate upon the valve gates in such a manner as to ensure the valve closing tightly.

YORKSHIRE COALOWNERS AND THE RAILWAY COAL CONTRACTS.—Although another week has passed and no tidings relating to the placing of next year's locomotive coal contracts have been made known, South Yorkshire coalowners are firm in regard to the advances they are seeking. A meeting to consider the situation was held on Tuesday, when it is said that there was a unanimous feeling in favour of quoted prices being realised. It was pointed out that this year collieries raising best South Yorkshire hards were in a better position than for some time past. That although most of the leading thick seam pits are working full time, stocks are comparatively light, and there is a great inducement for coalowners to stack steam coal for next season shipment, rather than take less prices than they have quoted. Firms working the best thick seams are reported as determined to hold out for the quoted rates. It is pointed out that a certain railway company, which for the past few years has obtained supplies of secondary coal, is this year asking for tenders at collieries where the coal is best suited for locomotive purposes. It is believed that the railway companies will withhold their decisions until nearer the close of the year, but it has leaked out that one of the largest coal-consuming companies has been trying to arrange for supplies from West Yorkshire firms by personal interviews.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

EMPLOYMENT continues regular and full in most of the engineering trades, a considerable amount of work being on hand. Engineers are pleased that the trade recovery which set in some months ago has continued so steadily, and that December has been reached with business still in a healthy state, and with prospects decidedly hopeful. Some firms have work enough on their books to last them well into the spring of next year, both from home and foreign sources, and since the workpeople are better occupied than for several years past, the industrial outlook is correspondingly more favourable, and the number out of employment this winter is likely to be less than usual. The percentage of men on the books of the Amalgamated Society of Engineers in the Midlands has shown a steady reduction of late. Makers of plantation tools are receiving better news from the Brazil coffee plantations, and also from tea planters in Ceylon, the inquiries on account of those markets being less restricted. Railway engineers are benefiting by railway construction in China and Japan. The Midland engineering trades stand in need of better conditions for the conveyance of goods, not only to South Africa but also to Australia, and the Birmingham Chamber of Commerce is in communication with the Board of Trade with a view to securing at least equality of treatment for British and American goods shipped to Australia. Railway traffic in and out of the Midlands on all the lines serving the district has of late been exhibiting an encouraging increase.

In the iron and steel trades producers still have the upper hand and are maintaining their quotations in all departments. It is not thought that the change of Government will interfere much with business. The definite step which has been taken is better than the previous uncertainty, for business men know now what to expect and can make their arrangements accordingly. It is expected that the general election will be over and done with before there has been time for the trade revival to be seriously impeded. Demand is not buoyant, consumers having apparently in most departments satisfied their requirements for the present, and as usual, within sight of Christmas, new buying is curtailed. There is, however, a great deal of work in hand, and producers consequently hold firmly to recent quotations. Staffordshire cinder forge pig iron is quoted 55s.; part-mine, 55s. to 60s.; all-mine ordinary, 62s. 6d.; and best all-mine, 87s. 6d. to 90s., with cold-air 105s. Northamptons are about 56s. to 57s. 6d. In the manufactured iron trade unmarked bars are quoted £6 15s. to £7, with a good out-turn, whilst marked bars are still £8 10s. There is a better call than recently for plain black sheets at £7 15s. to £8 for doubles, whilst makers of galvanised corrugated sheets keep busy, and quote £12 to £12 5s. as their minimum. Galvanisers are fairly well bought as regards spelter, and are trying to keep out of the market until the New Year, for this metal is still dear, and is quoted £28 12s. 6d. spot, with producers showing much independence. An improved output is being made of rivet iron at £7 5s., and also of slit nail rods at £7 10s. North Staffordshire "Crown" bars are quoted £7 5s. per ton; "Crown" angles, £7 10s.; and "Crown" plates, £8 15s., all of which have for some time past found a ready market. Manufacturers are disinclined to book further than the end of the first quarter of next year. Puddlers' wages are to remain at 8s. 6d. per ton from December 4th till February 3rd.

The Midland steelmakers are busy, the output being large, especially of engineering sections. Angles are quoted £6 15s. to £7; joists, £7 to £7 5s.; boiler plates, £8 10s. to £8 15s.; and girder plates, £7 10s. to £7 15s. Members of the engineering trades have been good buyers for a long while past.

Motor engineers are busy. Business with Russia in machine tools, pumps, and some other requisites is still greatly interfered with, and such transactions as occur are being placed as far as possible on a cash basis. The use of copper by electrical and other engineers in the Midlands is being economised as far as practicable on account of the rising prices of that metal, standard having touched £78 15s. since my last letter.

The Birmingham City Council has approved the various recommendations of its Gas and Electricity Committees as to lower charges, set forth in my last letter.

Mr. W. J. Davis, of Birmingham, has been appointed the first chairman of a new labour organisation, known as the Metal Trades Federation of Great Britain, having a membership at present of over 60,000. On the Advisory Committee of the new body, Mr. Davis will also represent the National Society of Amalgamated Brass Workers.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—With the advent of December there has been some slackening off in the demand for crude iron, and the "boom" of a few weeks ago has largely spent itself. The market has been disturbed to a certain extent by what has been termed "speculative activity" such as has not been known for a long period. It is generally admitted that it is healthy in tone; and although stocks in public stores continue to increase, this does not appear to affect the general position. In this centre, under the effect of large buyings a month or two ago, consumers have not ventured on ordering to any great extent; but, as trade is brisk, it may be assumed that it is only a matter of a comparatively short period that they will be again compelled to renew their stocks. Meantime, no large quantity is available, and that is mostly in merchants' hands. For next year, makers are open for business, and somewhat higher rates are quoted for English grades of foundry pig. There has been no information received yet that the Kirkless Hall brand will be put on the market again, which is rather noteworthy in face of the fact that it would now command a remunerative price in comparison with other sorts. It is said that the disorganised state of things in Russia is affecting Scotch iron, but there is now a tendency towards recovery. A fair quantity of Cleveland iron is coming into this district, but both East and West Coast hematite is dull and closes lower. Derbyshire, Lincolnshire, and Staffordshire show no change.

In forge iron, makers report that their output is fully absorbed on old contracts, and that in any case quotations are only of a nominal character. Exports of pig iron from Manchester to the United States, according to the Consul-General's report for November, amount to £4545—in itself a satisfactory feature when the "dumping" of two or three years ago at Manchester docks is remembered. Quotations for pig iron are as follows:—Lincolnshire, No. 3 foundry, 59s.; Derbyshire, 61s. to 61s. 6d.; Staffordshire, 60s.; Middlesbrough, open brands, 61s. 4d. to 61s. 10d.; West Coast hematite, 78s. 6d.; East Coast, 78s. 6d. net. Scotch: Gartsherrie, 67s. 6d. to 68s.; Glengarnock and Eglinton, 64s. to 64s. 6d.; Dalmellington, 63s. 6d. to 64s., delivered Manchester. For delivery Heysham—Scotch: Gartsherrie, 65s. 3d. to 65s. 9d.; Glengarnock and Eglinton, 61s. 9d. to 62s. 3d.; Dalmellington, 61s. 3d. to 61s. 9d. Delivery Preston: Gartsherrie, 66s. 6d. to 67s.; Glengarnock and Eglinton, 63s. to 63s. 6d.; Dalmellington, 62s. 6d. to 63s.

Finished iron has been a shade less in turnover, but holders are still adhering to full rates. Bars, £7 to £7 5s.; hoops, £7 10s.; sheets, £8 5s. to £8 10s.

Steel and steel products continue on the up grade, and it is noticeable that in foreign billets very little German is arriving except on unexpired contracts. The demand in that country will account for this. Bars, £7 5s.; hoops, £7 15s.; boiler plates, £8 2s. 6d. to £8 5s.; plates for tank, girder, and bridge work, £7 15s. to £8; English billets, £5 5s. to £5 12s. 6d.; foreign, £5; sheets, £8 15s. to £8 17s. 6d.

There is a fair inquiry reported for locomotives, and this, to some extent, has a good effect on manufactured copper, which remains firm at the recent advance. Sheets, £90 to £92 per ton; seamless copper tubes, 11d.; brazed, 10¾d.; brass tubes, 8¾d.; condenser, 9¾d.; brass wire, 8¼d.; rolled brass, 8¼d.; brass sheets, 9d. per pound.

Sheet lead is 5s. dearer, at £18 15s. per ton.

Good accounts continue to come to hand of activity in machine tools and textile machinery department.

The attendance on the Coal Exchange yesterday was fairly good, and about an average business was passing, although there was an undercurrent of uncertainty, and it was evident that coalowners were open to offers. House coal was generally quiet, but slack appeared to be in fair request. Manufacturing and coal for bunkering purposes showed little change. The proposed combine of Lancashire, Yorkshire, Staffordshire, and Derbyshire colliery proprietors came in for some discussion. Nothing definite, however, could be said, as at present the scheme is in embryo. The principal object aimed at is to prevent undue competition and to bring about a uniform rate of prices. We shall hear more of this shortly. Ordinary quotations:—Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine fuel, 7s. 9d. to 8s. 6d.; best slack, 7s. to 7s. 6d.; medium, 6s. to 6s. 9d.; common, 5s. to 5s. 9d. at the pit. Screened coal, 9s. 9d. to 10s.; unscreened, 9s. 3d. to 9s. 6d., delivered Manchester Ship Canal.

Barrow.—There is for the moment a quieter business in hematite iron, but this can only be temporary, as it is known that large deliveries of metal have not only been bought forward, but that large further requirements are needed by makers of mild steel, and the prospect is that the make of iron cannot be further materially increased, as, although only 37 furnaces are in blast, makers have no available blast, except in one or two instances, to put additional furnaces in blast. The heavier blasts now in vogue at West Coast furnaces enable smelters to produce a much larger tonnage of iron per furnace, but the blast which was distributed previously over a larger number of furnaces is now utilised for the smaller number at work, and, therefore, they have not the available blast power requisite to put in operation some of the furnaces which for a long time have been lying idle. This will result in narrowing the possibilities of development, and it is consequently anticipated prices will be firmer, if not higher. Makers are quoting 70s. 6d. net f.o.b. for mixed Bessemer numbers, and warrant iron is at 70s. net cash sellers, buyers 69s. 6d. Stocks of warrant iron have been increased during the week by 2750 tons, and now stand at 46,638 tons. It is probable these stocks will grow.

Iron ore is in fuller demand locally, as well as for supplies from Spain and other foreign countries, and prices are firm at 15s. per ton for good average native sorts net at mines, and 19s. for foreign ores of 50 per cent. quality.

The steel trade is quiet in rails, both as regards light and heavy sorts, and prices are at £5 17s. 6d. per ton for heavy sections. Buyers are declining to pay this figure, but it is expected if the price of hematite is maintained orders will perforce have to be placed. In that event the possibility of dearer hematite will at once be able to assert itself. The rail mills at Barrow are producing tin bars, but it is probable they will have to stand after this week until the new year. A good trade is being done in ship plates and shipbuilding material generally, and the mills are fully employed. £7 per ton is the current quotation. Merchant steel is quiet, and hoops are only in small demand. Heavy castings are in request, and a good business is being done in heavy castings and in chilled iron castings.

The shipbuilding trade is not busy. Vickers, Sons and Maxim have booked a second order for a Peruvian cruiser.

Shipping is more active. Last week the exports included 15,120 tons of iron and 10,182 tons of steel—a total of 25,302 tons, being an increase on the corresponding week of last year of 12,858 tons. The total exports this year have reached 766,643 tons, being an increase on the corresponding period of last year of 89,282 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE expectation expressed last week that the question of locomotive coal contracts would be settled in a few days has not yet been realised. At the time of writing—the evening of the 6th inst.—the matter remains open, with the position pretty much as it was a week ago. The tenders sent by South Yorkshire and Derbyshire coalowners are at figures exhibiting an advance of 6d. per ton on the rates now current. In making this request for an advance, which they regard as reasonable, the colliery proprietors are acting unitedly. They are confirmed in their attitude by the fact that steam fuel is in excellent demand, both for shipping purposes and on home account, and that, although the pits are working full time, there are no large stocks in hand. In fact, the market is stated to be quite equal to absorb the output, heavy as it is.

The condition of the coal trade, taken all round, is one which can be regarded with considerable satisfaction. Steam fuel, as stated, is in good demand, and likely to continue so into the new year, the collieries being well booked forward. In household fuel, though the weather is again much milder, the requirements are fully up to the average. The advance of 1s. per ton, decided upon by the London coal merchants this week, has had a stiffening effect on local business, though not to the extent of advancing quotations, except in one or two special instances, of coal required for immediate delivery. There is not much best Silkstone being dealt with, but what there is fetches readily from 12s. to 12s. 6d. per ton; secondary sorts making from 10s. 3d. to 10s. 6d. per ton; Barnsley thick seam house coal is at 10s. 6d. to 11s. for best selected; other qualities being obtainable at 8s. 3d. to 8s. 6d. per ton at the pits in owners' wagons.

The brisk business reported last week in gas coal is fully sustained. Although contract rates are rather under those of last year, best qualities of gas coal bought in the open market fetch a little more money. Small fuel, both in steam and house qualities, is moving more freely. Coke is also brisker, though prices do not increase. Best steel malting coke is quoted at from 23s. to 24s. per ton, blast furnace quality at 13s. 6d., and occasionally slightly over that rate.

The situation in the iron and steel trades, and in the heavy industries of Sheffield and district, presents no new features this week. Improvement has been steadily manifesting itself in the principal branches of manufacture. With the large establishments actively employed, there is corresponding activity in other directions. In military material the exception continues to be in respect of the armour-plate mills. Such work as is available is pretty well fixed, but there is no definite idea as to when it may be expected. Meanwhile, much valuable plant is standing idle, and, so far as can be seen, is likely to continue so for some time. In other branches of military work, such as on ordnance and projectile account, there is good work in progress. The engineering firms are much better employed than they were, a considerable portion of the machinery and plant now in course of execution being on account of the demands of Sheffield and adjoining districts.

In raw materials the latest quotations are firmly maintained, with no likelihood whatever of any weakening this year. West Coast hematites remain at 81s. 6d. per ton; East Coast at 78s., both less 2½ per cent. Lincolnshire No. 3 foundry is quoted at 56s. per ton; Lincolnshire No. 4 foundry, 54s. per ton; Lincolnshire No. 4 forge, 53s. 6d. per ton; mottled and white, 55s. 6d. per ton; basic, 55s. 6d. per ton. In the finished iron trade business is brisk. Steel manufacturers are exceptionally active in all departments. Bessemer and Siemens steels are being very heavily produced, consequent to a large extent on the demand for forgings and castings for heavy machinery, steam turbine work, shafting, cranks, specialities in electrical equipment, &c. The extensions now being pushed forward in several of the leading East End establishments, as well as in other parts, is finding good business for various firms who receive much of their trade from the larger houses.

Railway material, though not so freely placed as could be wished, is being more freely ordered than at any time during the year. A shortage of wagons is reported in several localities, and this is no doubt leading to the increased employment given. Wheels, tires, axles, buffers, springs, and similar specialities are also in satisfactory demand, both on home and distant account. The requirements of colliery proprietors are fully maintained, and this branch of local business is fully engaged. Boilermakers and repairers are well employed in nearly all directions.

The tool trades are also improving, the orders received during the last few weeks having been sufficient largely to augment employment for the men. There is an excellent demand for picks, hammers, shovels, and mining and excavating tools of all descriptions, chiefly on foreign account, though the home market is giving acceptable signs of picking up. For South Africa the work is mainly in specialities for mining and crushing machinery and other appliances required in the Transvaal and neighbouring field. The South African business, though much better than during the early part of the year, is not equal to what was anticipated. Confidence in its future, however, is freely entertained by the houses largely concerned, and an increase of business is looked for in the New Year.

In the lighter industries of Sheffield, such as cutlery, silver, and plating, the usual Christmas demand is now being experienced. It is satisfactory to hear more encouraging accounts of the business done in specialities for the season not only in London, but with the merchants in the principal provincial centres. Although the orders are somewhat unequally divided, we gather from different quarters that the condition of affairs is decidedly better than it was twelve months ago.

The Council of the Sheffield Chamber of Commerce has decided to hold a meeting of the members on December 18th to hear an address by Mr. C. E. Musgrave on trade mark registration in India. In reference to the amalgamation of the Great Central, and the Lancashire, Derbyshire, and East Coast Railways, a resolution was passed expressing approval, and the belief that the new arrangement would give increased facilities to the trade of Sheffield.

NORTH OF ENGLAND.

(From our own Correspondent.)

NOTWITHSTANDING several adverse influences this week, the position of producers in the iron and steel industries has improved, and buyers have been more anxious to purchase than for some weeks. Among the adverse influences may be included political affairs at home; then there is the disturbed state of matters in Russia, and there are also to be considered the unsatisfactory statistical returns. But, after all, these have affected the iron and allied trades less detrimentally than might have been looked for, and the bad returns are counterbalanced by the views that are almost universally held about the encouraging prospects for next year. Consumers do not hesitate to buy for delivery well into next year, and in some branches orders for execution in 1907 could readily be secured.

That prices do not advance more steadily in the Cleveland pig iron trade is due to the plethora of iron produced. This branch undoubtedly has not experienced anything like the measure of revival that has been reported in the steel industry, and with it the hematite pig iron business. It is to be borne in mind that so far the "boom" has been mainly in steel, the improvement in iron being comparatively small. And yet in the face of this the production of Cleveland pig iron has been increased by the blowing in of several furnaces, with the result that the stock in the public stores has gone on at a greater rate. Instead of re-lighting furnaces to produce Cleveland pig iron, some should have been blown out, as they could not very well be put upon hematite iron, owing to the scarcity of ore. The market, however, could well have done with a larger output of hematite. Makers of Cleveland iron believe that next year trade will be so good that all the iron that is produced will be taken up, and the stock in the public warrant stores will be heavily drawn upon into the bargain. Thus they keep the production up, more especially as they are securing a very fair price for what they do sell. For No. 3 Cleveland G.M.B. pig iron their price this week for prompt f.o.b. delivery has been mostly at 53s. per ton, or 6d. above the minimum of last week. No. 1 is at 54s. 6d.; No. 4 foundry at 51s. 6d.; No. 4 forge at 51s.; mottled at 50s. 9d.; and white at 50s. 3d. per ton.

The situation as regards the stock of Cleveland pig iron in Connal's public stores is unprecedented, and the surprise is that the prices of Cleveland pig iron are so well maintained. Last month the increase was 29,538 tons, the previous month 33,396 tons, and since January 1st it has been 476,815 tons, or an average of 43,000 tons per month. The total stock on November 30th was 668,642 tons, against 75,000 tons about sixteen months ago. When it is considered that the output of Cleveland pig iron in the Cleveland district is about 1,600,000 tons per annum, it will be seen that more than 25 per cent. of what has been produced this year has not gone into consumption, but into Connal's public stores.

The hematite iron trade is in a very satisfactory condition, and producers have the best of grounds for anticipating that this will be the condition of business all through next year. They cannot very well satisfy all the steel manufacturers, and would produce more if they could. No one has any stock, and the quantity held in Connal's is but 3396 tons. The price of mixed numbers is 70s. per ton for prompt f.o.b. delivery, and 71s. 6d. for delivery over the first quarter of next year. No. 4 is at 65s. Not less than 18s. 9d. per ton will be accepted for prompt deliveries at wharf on Tees or Tyne of Rubio ore, but 19s. is asked for delivery next half year. There would have been a greater difference, but the rates of freight are being reduced, as is usual when the Baltic season closes, for then there are more steamers offering for employment in the ore trade. The rate Bilbao to Middlesbrough, which was up at 6s., is now back to 5s. 7½d. per ton.

A very poor record of shipments of pig iron from the Cleveland district is issued for November, the worst, with the exception of that of the corresponding month last year, that has been compiled in any November since 1893. Only 77,503 tons were exported, against a November average over the last ten years of 93,000 tons, the falling off thus being over 17 per cent. Moreover, this return is under the average for the current year, bad though that has been. It is mainly Cleveland iron that is exported, and in that branch the improvement has been small; the hematite iron made is chiefly consumed in the district. The 77,503 tons sent away last month compares badly with the best November, which was in 1896, when 124,400 tons were exported. The decreased trade has been on oversea account, there being heavy decreases in the deliveries to Germany, Italy, Belgium, Norway, &c., and the total oversea deliveries have been worse than in any month since April, 1904, except in January last. Shipments to Scotland, however, were better than in any month since April, 1904.

It is officially announced that owing to the success which has attended the working of the Talbot steel furnace, which was started at Cargo Fleet Works in the early part of September last, the South Durham Steel and Iron Company have determined to adopt this type of furnace at two of their establishments—the Stockton Malleable and the West Hartlepool Steel Works. The steel produced at Cargo Fleet from this Talbot furnace has been accepted by Lloyd's and other surveys for plates and sections.

The inquiry for heavy steel rails is again improving, and the price has been raised to at least £5 17s. 6d. per ton net f.o.t., though more generally £6 net is quoted. It is satisfactory to note that the German competition in semi-manufactured steel is fast declining, and the imports are nothing like they have been for the

last three years. Local producers are thus getting back their trade. The Germans are quoting higher prices for their steel, and now the home-made product is cheaper for the consumer in this district. The demand in Germany for this semi-manufactured steel has improved so much that practically there is no surplus production, and thus there is no need for makers there to send supplies over to us at a loss to themselves, as they have been doing.

The plate and angle manufacturers have abundance of orders, and almost all of them hold the opinion that 1906 will be a "boom" year; in fact, they are mostly already assured of that. For steel ship plates £7 is the price; for steel boiler plates £8; for iron ship plates £7 5s.; for steel ship angles, £6 12s. 6d.; for iron ship angles, £7 5s.; for parallel packing iron, £8; for iron ship rivets, £7 17s. 6d., all less 2½ per cent f.o.t. The bar makers are likewise well situated; they have plenty of work at very fair prices, and they do not want to check the trade by further advancing quotations just yet. Steel hoops are at £7 5s.; steel strip £6 15s.; steel bars, £6 15s.; iron bars, £7, all less, 2½ per cent. Chair and pipe founders are doing better, but the revival has been very slow in coming their way, and they have had heavier costs without getting better prices to cover them.

The "boom" in shipbuilding is over for the present, and there is not much ordering of new steamers. It has lasted some three months, and during that time the builders have done well with regard to the amount of work they have secured; in fact, they have become assured of full work at their yards for 1906; but it must be remembered that the larger proportion of the orders were booked at the low prices, and probably it is the raising of the quotations which has checked the demand. The engineers have likewise profited by the "boom" in shipbuilding, and have reason to expect a brisk year in 1906.

More activity is reported in most branches of the coal trade of the North-East of England, consumers buying more freely, partly to tide them over the holidays. Fuller employment is afforded at the collieries, and prices have been more favourable for sellers. Thus best steam coals are again up at 9s. per ton, and seconds at 8s. 3d., both f.o.b. The same figures rule also for gas coals, of which the shipments have increased considerably. As regards coke there is at last an improvement. For some months the production has slightly exceeded the consumption, and it has been impossible to get the prices up in sympathy with the advances in pig iron. But all the surplus coke has now been taken off the market, and now supply is not in excess of demand. This has enabled the sellers to raise their quotations, and both for prompt and forward delivery the rate has got up to 17s. per ton for medium qualities delivered at the furnaces about Middlesbrough, or something like 15s. per ton at the ovens. The Durham miners are endeavouring to get the coalowners in future to put bath-rooms in any miners' houses which they may build, and the Association has passed a resolution to this effect. It is advocated as an alternative that baths should be provided at the collieries, as is generally the case in Germany; in fact, this is compulsory on the coalowners there by the law of the land. Several of the Cleveland ironmaking firms have provided such baths at their works.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE was much business done in the Glasgow pig iron warrant market towards the end of last week. Local holders were understood to be heavy sellers, being desirous of selling out, owing to the large accumulation of stocks at Middlesbrough. At the same time there was no want of buyers, so that the business was done without any great depreciation in values.

The demand for pig iron on the part of home consumers and shippers is at the moment only moderate. The wants of the trade seem to be well met, and the opinion is that there will be no great pressure for raw iron before the turn of the year.

The demand for hematite pig iron has been quiet, and prices are somewhat easier. Cumberland iron is quoted 68s. 6d., and Scotch hematite is nominally 74s. for delivery at the West of Scotland steel works, but in the meantime the requirements of consumers seem to be well met.

Business has been done in Cleveland warrants this week at 52s. 6d. to 53s. 1d. cash, and 52s. 11d. to 53s. 4d. one month, 53s. 1½d. being also taken for delivery in eleven days. Scotch warrants are quoted 57s. 9d., and standard foundry pig iron 52s. per ton. The latter price is about 6d. better than the rate quoted a week ago.

The output of pig iron in Scotland shows some increase. An additional furnace has been lighted to produce ordinary iron, and there are now 49 making hematite, 36 ordinary, and 6 basic iron. The total of 91 thus blowing in Scotland compares with 85 at this time last year.

The prices of Scotch makers' iron show very little change. G.M.B., No. 1, is quoted at Glasgow 62s.; No. 3, 59s. 6d.; Carnbroe, No. 1, 65s.; No. 3, 62s.; Clyde and Calder, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Gartsherrie, No. 1, 68s.; No. 3, 63s.; Summerlee and Langloan Nos. 1, 70s.; Nos. 3, 65s.; Coltness, No. 1, 76s.; No. 3, 66s.; Glengarnock at Ardrossan, No. 1, 68s.; No. 3, 63s.; Eglinton at Ardrossan or Troon, No. 1, 62s. 6d.; No. 3, 60s.; Dalmellington at Ayr, No. 1, 65s.; No. 3, 60s.; Shotts at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d.; Carron at Grangemouth, No. 1, 70s.; No. 3, 65s. per ton.

The stock of pig iron in Glasgow warrant stores shows the smaller decrease of 40 tons in the past week, and now consists of 16,148 tons ordinary, and 6500 standard foundry pig iron.

The shipments of pig iron from the Scottish ports in the past week amounted to 5696 tons, against 3302 in the corresponding week. There was despatched to Canada 105 tons, South America 315, India 105, Australia 625, France 180, Italy 440, Germany 15, Holland 135, Belgium 20, China and Japan 403, other countries 369, the coastwise shipments being 2984 tons, compared with 2335 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth in the past week amounted to 8739 tons, being 1239 tons less than in the corresponding week of last year.

The finished iron and steel trades are busy, but there has been less doing in new orders.

The steel trade is exceptionally well supplied with work, a large part of it connected with shipbuilding.

Marine engineers are very busy, and so are tube makers and makers of general ship furnishings.

The pipe founding trade is comparatively quiet. Several firms have fair orders on hand, but the general inquiry is unsatisfactory.

The output of new shipping on the Clyde during November embraces twenty-two vessels, measuring 55,358 tons, compared with seventeen vessels of 25,118 tons in November last year. The output for the eleven months ending November has been 472,911 tons, the largest in any similar period on record, and it compares with 357,944 tons in the corresponding period of last year. It is estimated that during November 75,000 tons of new shipping was placed with the Clyde shipbuilders. This included a number of cargo and passenger steamers of good size, varying from 3000 to 9000 tons. In the last week or two the inquiry for new vessels has fallen away. The freight market has been somewhat disappointing, and it is thought that the rush for building new vessels is over for the present. At the same time, there is work on hand that will keep all employed in the trade busy for a long time to come.

There has been rather less doing in the shipping department of the coal trade, and this has been particularly noticeable on the Clyde and in the Fifeshire district. The falling off in shipments amounts to about 12,000 tons from the whole of the Scottish ports, compared with the preceding week, and they are 24,000 tons less than in the corresponding week of last year. There is not much reason to complain, however, of the state of business, when it is noted that the shipments from Scotland for the year to date are fully half a million tons larger than in the corresponding period of 1904. There is practically no change in shipping prices. The coalmasters of the West of Scotland have raised the price of splint coal for home use 6d. per ton, beginning with the present month for contracts. There is a good demand for household coal for home use at steady prices.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

IT is early yet to speculate upon the results of the new agreement. Tonnage came in more freely to Swansea and Newport last week, and slightly improved the conditions of trade, but at Cardiff there has not been a marked lessening of the congestion on sidings. With improved weather coalowners expect to be brisk between the next week and Christmas, and as regards the leading coalowners holding large contracts over next year, there is not much anxiety. The smaller coalowners are not so hopeful, and openly predict stoppages. The result of the new agreement is, they say, to maintain high prices and high wages, and, in the face of keen rivalry, this policy is considered bad. South Wales owners have to contend with the keen rivalry of the North of England, which has during the present year secured a good deal of tonnage previously obtained by Wales; and Germany is strenuously at work in the French market. Possibly the home trouble of the latter may lessen this. At present France continues one of the largest buyers of Swansea coal, and, in even the present slack times at Cardiff, takes a fair share of the export.

Substantial requirements of Welsh coals will be needed by the Admiralty next year. Usually a million tons are wanted, sometimes a million and a quarter. Next year it is expected to total 800,000 to a million. Coalowners have been notified to send in particulars.

Latest quotations were:—Best steam, 12s. 3d. to 12s. 9d.; best seconds, 11s. 9d. to 12s.; seconds, 11s. 6d.; drys, 11s. to 11s. 9d.; best smalls, 8s. 3d.; best ordinaries, 7s. 6d. to 8s.; seconds, 7s. 3d. to 7s. 6d.; inferiors, from 6s. 9d. Monmouthshire semi-bituminous coal: Best large, 11s. 9d.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d. House coal: Best, 16s. to 16s. 3d.; best ordinaries, 13s. 6d. to 15s.; seconds and other sorts, 10s. 6d. to 11s.; No. 3 Rhondda, 13s. 6d. to 13s. 9d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 9d.; No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 6d. to 8s. 9d.; small, 7s. 6d. to 7s. 9d. Patent fuel unchanged, 13s. 3d. to 13s. 6d. Coke firm, 16s. 6d. to 17s. furnace; 18s. 6d. to 22s. foundry. Pitwood slightly easier, 21s. 6d. to 21s. 9d. Shipments improving from France, Spain, and Ireland, but wagons short.

Ebbw Vale district is the arena of dispute on the doctors' question, now waging between the men's committee and the Medical Association, which champions the local medical men.

Steel rails for India, Buenos Ayres, and the Pacific Railway continue to command attention at the leading iron and steelworks. Last week 2180 tons left Cardiff for Kurachi. The Buenos Ayres rail is being turned out at Dowlais, and is 100 lb. to the yard.

From Newport, Mon., important consignments of rails and fishplates left for the Great Western lines. Cargoes of pig iron have frequently come to Wales from Harrington and Middlesbrough, but last week a total of over a thousand tons of tin bars came from the places named, consigned to Wilks and Co., Newport. Newport also has been the preliminary destination, previous to despatch for various tin-plate works, of 2772 tons of bars and 295 tons of billets from Antwerp.

It was stated on 'Change, Swansea, this week that local make had been insufficient to meet requirements in tin bar, and that serious complaints had come to hand of inconvenience caused at tin-plate works in consequence.

There was a good deal of animation on 'Change, Swansea, midweek, and considerable buoyancy shown in metals generally. It was remarked by an authority that since November 1st a well-sustained increase had taken place: Copper, from £71 5s. to £77 5s.; tin, from £149 10s. to £160; spelter, from £28 7s. 6d. to £28 10s.; lead, from £15 5s. to £16 12s. 6d. In pig iron, Middlesbrough, from 52s. 9d. to 53s. 2d. Scotch pigs, on the other hand, have decreased from 58s. to 57s. 9d.; hematite, from 70s. to 69s. But in the case of hematite, it has, from October, indicated marked changes. In October it touched 72s., and during November fluctuated between 72s. and 69s.

It has followed that tin-plate makers have not had an easy time to adjust prices based on these changes to suit customers, and buyers, in consequence, hold back. Few doubt but that Russian trade will eventually recover, and lost business be regained, to be followed by improved figures.

Tin-plate business is rather quiet, though hopeful, with an improved tone on the Continent. Shipments, owing principally to climatic conditions last week, were limited to 45,098 boxes; receipt from works, 49,089 boxes; present stocks, 202,129 boxes. Latest quotations of metals generally:—Pig iron: Bessemer mixed numbers, 69s. 1d.; Welsh make, 72s. 6d. f.o.t.; Middlesbrough, 53s. 2d.; Scotch, 51s. 2d.; Siemens steel bars, £5 2s. 6d. to £5 5s.; Bessemer, £5 to £5 2s. 6d. Tin-plates: I.C. 20 by 14, 112 sheets, 108 lb. Bessemer primes, 13s. 3d. to 13s. 6d.; wasters, 12s. 6d. to 12s. 9d.; Siemens primes, 13s 6d. to 13s. 9d.; wasters, 12s. 6d. to 12s. 9d.; I.C. 28 by 20, 56 sheets, 108 lb. Bessemer primes, 13s. 9d. to 13s. 10½d.; wasters, 12s. 9d. to 13s.; Siemens primes, 13s. 9d. to 14s.; wasters, 12s. 9d. to 13s.; I.C. 23 by 20, 112 sheets, 216 lb. Bessemer primes, 26s. 9d. to 27s. 3d.; wasters, 25s. 3d. to 25s. 6d.; Siemens primes 26s. 10½d.; wasters, 25s. 3d. to 25s. 9d.; I.C. 20 by 10, 225 sheets, 156 lb. Siemens primes, 18s. 9d.; wasters, 17s. 6d. to 17s. 9d.; I.C. 18¾ by 14, 124 sheets, 110 lb. Bessemer primes, 13s. 6d.; wasters, 12s. 6d. to 12s. 9d.; I.C. 19½ by 14, 120 sheets, 110 lb. Bessemer primes, 13s. 6d.; wasters, 12s. 7½d. to 12s. 8d.; odd sizes, 13s. 6d. to 13s. 9d.; Siemens prime, 14s.; big sheets for galvanising, 6ft. by 3ft., £10 15s. per ton; C.A. roofing sheets, £13 per ton; finished black plates, £10 5s. to £10 10s., all f.o.b. Swansea, cash in fourteen days less 4s. per cent.

Block tin is now at £160; lead, £16 12s. 6d., for English, Spanish, £16 7s. 6d.; copper, £77 5s.; silver, 29⅝s. per oz.; spelter, £28 15s. Iron ore, Cardiff and Newport: Rubio, 17s. 6d. to 18s.; Almeria, 17s. to 18s. on a basis of 50 per cent. iron. Nickel is in good demand. Spelter and copper busy.

It is understood that the arrangements between the Barry and Brecon and Merthyr Railway Companies are nearly completed, and that the sanction of Parliament will be put forward for powers to lease the latter without any delay.

Wales is now up in arms against any more appropriation of water areas. The Water Committee of the Glamorgan County Council have decided to recommend the council to adopt the draft Bill, empowering the formation of a Joint Water Board for the six counties of South Wales, with the object of protecting the water area of Wales, and for supplying water to the various districts in these counties.

Latest report: Coal prices practically unchanged. Swansea steam, 12s. 6d. to 13s.; No. 3 Rhondda, 13s. 6d. to 14s.; best anthracite from 19s.; red vein better, 9s.; big vein, 13s. 3d. to 13s. 9d.; cobbles, 17s.; nuts, 17s. 6d. to 19s. 6d.; peas, 10s. 6d. to 11s.; rubbly culme, 4s. 3d. to 4s. 6d.; duff, 3s. to 3s. 6d. Patent fuel, 11s. 6d. Good under tone in coal. Spanish railway contract for 20,000 tons fuel is given out, but particulars have not transpired.

NOTES FROM GERMANY.

(From our own Correspondent.)

MAKERS of iron and steel in Rheinland-Westphalia are well employed and have good prospects generally. Pig iron maintains the firm tone of previous weeks, and semi-finished steel is very briskly called for. Prices have been slightly raised, and will further improve in the next quarter. Deliveries in semi-finished steel in October of the present year were 177,186 t., as against 170,815 t. in September, 1905, and against 142,160 t. in October, 1904. The shops engaged in the production of railway material are vigorously employed, deliveries in October having been 156,772 t., against 133,868 t. in September, 1905, and against 121,290 t. in October, 1904. The general position of the rail trade may be considered favourable, the export business having materially improved since the spring, both as regards prices and the number of contracts received. In sectional iron 132,996 t. were delivered in October, against 146,079 t. in September, 1905, and 99,549 t. in October, 1904. Deliveries in semi-finished steel in October of the present year show the highest figures hitherto attained.

The Siegerland iron market has exhibited much strength recently, and in some branches quotations have met with a further advance. At the iron ore mines output is heavy, and as there is no lack of workmen now, the next few weeks are going to be very active. Crude as well as finished iron sells freely. The sheet mills are amply provided with orders, and need not fear being hard up for work during the winter months. Plates have also been in fair request, prices tending upwards. Bars, both in iron and steel, are well inquired for, though, of course, compared to last quarter, a falling off can be noticed. At a recent meeting of the nail and rivet shops, employment was stated to be satisfactory at the various establishments, and a rise in quotations was resolved upon.

Accounts received concerning the iron industry in the Saar and Mosel district state activity and demand to be healthy and generally increasing. An extremely active business is done in pig iron, and the position of the semi-finished steel trade is also favourable, and home quotations are likely to meet with an advance before long. Railmakers are well supplied with orders, while girders show but little life. The Steel Convention has raised the price for sectional iron to M. 112.50 and M. 114 p.t. free Diedenhofen. For sales of 70 tons consumers and small dealers get a bounty of M. 0·50 p.t., and for sales of 150 t. M. 1 p.t. is granted. Prices tend upwards; at present sheets cannot be obtained at less than M. 122 p.t., and for plates M. 118 and M. 120 p.t. is about the lowest price quoted.

Business transactions on the Silesian iron market continued to be of a satisfactory description all through last week. Active employment is reported in the malleable iron and steel department. In plates and sheets a pretty extensive trade has been done; in the bridge-building and general structural department an animated business is also being transacted, and the finished iron industry is likewise well occupied, chiefly on orders for local requirements. Switches and crossings are in particularly good request.

Coal is in vigorous demand on the Rhenish-Westphalian market, and the want of wagons continues. The pits in the Ruhr district have resolved on a rise in prices for next quarter, but nothing definite is known as yet.

From the Silesian coal market very good accounts are likewise received, increasing demand and a consequent rise in quotations being generally noticeable. Consumers and dealers purchase very freely, as a colliers' strike is still considered not unlikely.

Though quiet in the principal departments, the Austro-Hungarian iron industry has still shown a fair amount of strength during the week now past, and some branches have been pretty well engaged on home orders. The bridge-building establishments, for instance, are well occupied, having secured several orders for local bridges. The wagon factories continue moderately well engaged, but they feel the competition of Belgian, German, and French companies very keenly. Recently the United Hungarian Wagon Shops have secured an order for 613 wagons, worth about 3,000,000f., for the Bulgarian railways. Wagons have also been exported to Servia from Austria-Hungary, and the Anatolian and Oriental railways granted some small orders; but in a late tendering for large supplies for the Italian railways the Austrians were beaten by Belgian firms, which sent in the lowest offers.

Regarding the business on the Austro-Hungarian coal market, the accounts of previous weeks can only be repeated, nothing of any special moment having occurred since then. Demand all round is active and increasing, and wagons are more scarce than ever. Still a lively tone prevails generally, and quotations tend upwards. The Elbe traffic in brown coal was much lower during the last two weeks of November this year than last, 400,000 q. coal less being delivered than in the same period in 1904.

Both in Belgium and in France the position of the iron market is stated to be animated and satisfactory. In Belgium the scarcity in pig iron increases, and in both countries the tendency of quotations is in an upward direction.

Demand and consumption in coal on the Belgian market are very active, and stocks rather limited. One need not wonder, therefore, that an upward move in prices can be noticed in many instances.

Of the French coal trade fair accounts can likewise be given, all sorts of engine and house fuel being in very good call.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market: Owing to rough weather, arrivals have been delayed, but there are better prospects for the coming week. Prices unchanged. House coal in fair demand. The quantity of coal shipped for the week ending December 2nd was 58,241 tons; foreign, 41,271 tons; coastwise, 16,970 tons. Imports for the week ending December 5th were:—Iron ore, 25,649 tons; steel bars, &c., 9391 tons; manganese ore, 1500 tons; spelter, 150 tons; cement, 120 tons; pitwood, 2680 loads.

Coal:—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 3d. to 10s. 6d.; house coal, best, 14s.; dock screenings, 7s. 6d. to 7s. 9d.; colliery small, 7s. 3d. to 7s. 6d.; smiths' coal, 9s. Pig iron: Hematite warrants, 69s. 3d.; Middlesbrough No. 3, 52s. 10½d. f.o.b. Cumberland, prompt. Iron ore:—Rubio, 17s. 6d. to 18s. Steel:—Rails, heavy sections, £5 10s. to £5 15s.; light ditto, £6 10s. to £6 15s.; Bessemer steel tin-plate bars, £5 to £5 2s. 6d.; Siemens steel tin-plate bars, £5 2s. 6d. to £5 5s., all delivered in the district, cash. Tin-plates:—Bessemer steel, coke, 13s. 3d. to 13s. 6d.; Siemens, coke finish, 13s. 6d. to 13s. 9d. Pitwood, 21s. 6d. ex ship. London Exchange telegrams:—Copper, £77 2s. 6d. to £77 5s.; Straits tin, £160. Freights firm.

CONTRACTS.—Messrs. Bennis and Co., Limited, have sent us a list of orders which have been recently received for their mechanical stokers and furnaces. Among the orderers of these we notice the Wimbledon Urban District Council, the Swadlincote (Derby) Urban District Council, the Rugby Urban District Council, Clarke, Chapman and Co., Limited, the Patent Shaft and Axletree Company, Limited, and the Babbington Coal Company, Limited.

BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—The annual meeting of this Association was held at the Grand Hotel, Birmingham, on Saturday. The President, Mr. R. Holiday, occupied the chair, and there was a large attendance of members. Messrs. W. Playdon and F. J. Cook gave interesting reports of their visits to the annual dinners of the Newcastle and Woolwich Associations, a vote of thanks being awarded to them for their services. Officers were elected as follows:—Mr. T. H. Dacres, president, vice Mr. R. Holiday; Mr. A. Cooke, vice-president, vice Mr. T. H. Dacres; Mr. C. Y. Hopkins, treasurer, vice Mr. A. Cooke. Messrs. W. Deakin, W. H. Dugard, E. A. Dowson, H. J. Grant, and J. Bettany were elected Council members; Mr. T. E. Mitton as trustee; Mr. G. Thompson as auditor; and Messrs. L. O'Brien and W. Playdon were re-elected as secretary and assistant secretary.

AMERICAN NOTES.

(From our own Correspondent.

NEW YORK, November 22nd.

ENORMOUS buying is still the feature of the iron and steel trade. The producers have been taken by surprise, and the surprise has been sustained for months. Nearly all of the business that is now done has reference to the needs of buyers for the coming year. Nearly all of the railroads of the country are making provision for road bed necessities as well as for mechanical equipment, and many of them for terminal facilities. The shipyards are also in the market for supplies which will extend over all of next year. The lake shipyards are also heavy buyers of material, and all of the yards have booked orders for vessels to engage in the lake trade from the extreme western points to the extreme eastern. There is also a great deal of material wanted for wharves and piers and for railroad facilities to load vessels at shipping points. The car builders are also once more buying heavily, as abundant orders have recently been booked for steel cars. The Pennsylvania Railroad, for instance, has thrown 12,000 wooden cars into the scrap heap rather than take the trouble to repair them. It is a question of capacity which decides this policy. A considerable percentage of these cars is serviceable, but when compared with the economy of the immense steel cars their use involves a loss from every point of view. Three or four of the other large systems have practically determined upon the adoption of a similar policy with reference to their rolling stock, and it is said, on very good authority, that a large percentage of the wooden cars are to be thrown aside as soon as the car builders are in a position to accept the business of replacing them with steel cars. The larger engineering plants have been taken by surprise recently by the volume of business crowded upon them, which consists of the manufacturing of mill and shop equipment of larger units than heretofore. There is a reorganisation of mill and shop capacity going on in this country which means the breaking up or casting aside of a very large amount of excellent machinery, but which has become outclassed by the larger machinery and equipments which have been designed and constructed in some of the larger engineering plants.

The United States Steel Corporation has had negotiations hanging fire for several weeks over a very large lot of Bessemer pig, and the trade is awaiting the announcement of the transaction.

Tin-plates have advanced 10 cents per box.

An immense amount of business is being done in manufactured steel for industrial plants, commercial buildings, and railroad bridges.

An order has been placed for 30,000 tons of steel rails for an electric road.

There is considerable excitement in the market this week over electrolitic and lake copper. Electrolitic has sold as high as 17·20 c.i.f. Europe, and 17 cents in this city. Re-sales of electrolitic copper afloat for Russia have been made for delivery in Paris. The exports of copper for the first nineteen days of November were 8319 tons. The consumptive demand is very light. Exports of pig lead since January 1st, 1,317,820 pigs, against 1,217,015 pigs same time last year. Receipts of spelter since January 1st, 2,860,720 slabs, against 2,598,015 slabs last year.

NEW YORK, November 29th.

The extraordinary demand for pig iron is shown by the urgency with which the buyers are demanding shipments. Production is going on at a satisfactory rate, but there is some difficulty in making shipments due to a dearth of labour for loading, and because of a scarcity of cars at many furnaces. A large amount of business is still being done in crude iron at both north and southern furnaces, and consumers are still anxious to cover their requirements just as soon as business is taken calling for iron. The recent bulletin of the American Iron and Steel Association shows that the total producing capacity on November 1st was 28,635,000 tons, and that this output will be increased by the product of sixteen furnaces now under construction, and which will come into blast between this date and June next. The demand for steel rails is heavy, and the contracts for the past week will aggregate in the neighbourhood of 100,000 tons. The demand for structural material and plate is also very heavy, and the existing capacity will scarcely be able to cope with the demand which will be presented next year, and which will be of a most urgent character, according to authentic information now at hand.

There is trouble ahead in both the anthracite and bituminous coal-mining regions. The contracts with the miners in both regions expired on April 1st. The miners have been actively building up their organisation with a view to making demands in the anthracite region for an eight-hour day. The larger consumers have been accumulating stock, but the great body of smaller consumers are unable to do so, and should a strike occur they will be put to much inconvenience. An operators' alliance is being formed in the Western States representing the soft coal mining interests, where 150,000 miners are employed. A meeting was held at Chicago on November 25th, at which 90 per cent. of the bituminous coal mining interests were represented. It was resolved to form a national association of bituminous coal mine operators, in order to act in harmony in the event of a contest with the miners, which now seems probable.

Refined copper is now quoted at 17⅛ to 17⅓ cents for lake and electrolytic, and 16¾ to 17 cents for casting grades. The exports for the past week were 1551 tons, the lightest export for one week for three years. The accumulation of copper in this country for November is estimated at 10,000 tons.

A strong tone prevails in the tin market, prices having advanced from 30 to 40 points in sympathy with London. Arrivals during the week, 1060 tons. The principal demand during the past week has been from steel corporations.

Lead continues strong at 5·65 to 5·75. Price at St. Louis, 5·50 spot. Refined spelter is quoted at 6·20. The outlook is for a continuous demand in metal, and prices will probably be maintained without difficulty.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE learn that Mr. Alfred Harold Wiggin, of Selly Oak, near Birmingham, has been elected a director of the Midland Railway Company, in place of Mr. Lewis R. Starkey, resigned.

MR. GEORGE A. GOODWIN, Memb. Inst. C.E., Whitworth Scholar, and Past-president of the Society of Engineers, has removed his offices from 28, Victoria-street to 25, Victoria-street, Westminster.

WE understand that the business of the Ryknield Engine Company, Limited, Burton-on-Trent, will be taken over by a new company now in course of formation, which will probably be known as the Ryknield Motor Company.

MR. JAMES BLAKE informs us that he has transferred his interest in the Blake patent boiler to the Blake Boiler, Wagon and Engineering Company, Limited, Alliance Works, Darlington, which will in future manufacture the boilers under his personal supervision.

BRUCE PEEBLES AND CO., Limited, have transferred their London office from Westminster to No. 1, London Wall-buildings, E.C., which will be the head-quarters of Mr. Roland S. Portheim, managing director, with Mr. Morton Beales as manager, and Mr. W. J. W. Bullock as chief engineer of the contract department.

MR. M. M. GILLESPIE, lately on the staff of the British Westinghouse Electric and Manufacturing Company, has started business on his own account, his offices being at Amberley House, Norfolk-street, Strand, W.C., where he will represent, among other firms, Messrs. Browett, Lindley and Co., for London and the South and West of England.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS**, *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

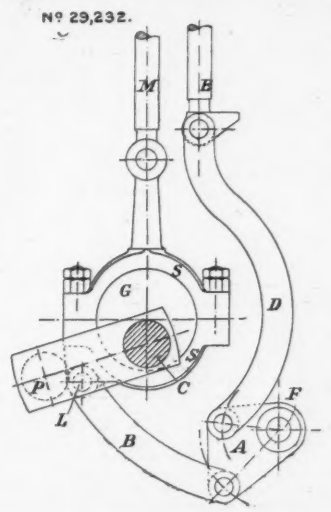
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

29,232. December 31st, 1904.—IMPROVEMENTS IN EXPANSION VALVE GEAR FOR STEAM ENGINES, James C. Merryweather and Christopher J. W. Jakeman, Greenwich-road, London, S.E.

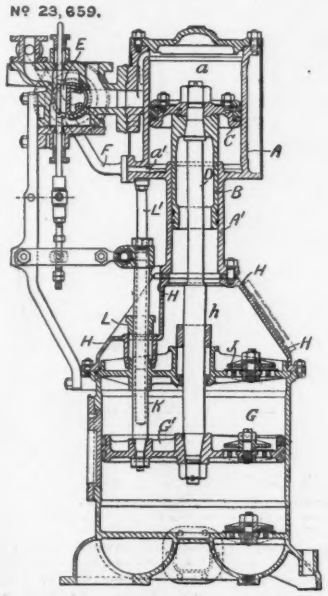
This invention relates to the method of working expansion valves for varying the cut-off in the cylinders of steam engines, and consists in driving the cut-off slide of a double slide valve gear from the same excentric as the main slide. The method by which motion at a correct time is obtained is by taking the movement of a suitable part of the excentric strap and transferring the motion by bell cranks and rods to a direction parallel to the movement of the main slide, but at a different time, thus producing the same effect as would be obtained by a separate excentric, as in the usual



construction of this gear. The valves may be slide valves or of the semi-rotary or any other type actuated by reciprocating rods. There is one drawing showing this. C is a section through the crankshaft which carries an excentric G placed in a suitable position with regard to the crank-pin P, and driving the main slide valve spindle M in the usual way. The excentric strap S carries a lug or projection L from which motion is imparted through the link B to a lever A rocking about a fulcrum F. This lever transfers the motion in another direction through the link D to the spindle E carrying the cut-off slide.—*November 8th*, 1905.

23,659. November 2nd, 1904.—IMPROVEMENTS IN STEAM ENGINE AIR PUMPS, William Weir, of Messrs. G. and J. Weir, Limited, Holm Foundry, Cathcart, Renfrewshire, N.B.

This invention has for its object to improve the working of vertical air pumps of the single acting type when these are driven independently and directly by the piston-rods of steam cylinders, to overcome the defects in working of this type of pump due to the unequal and unbalanced loads on the air pump piston on its upward and downward stroke, and to diminish the height and

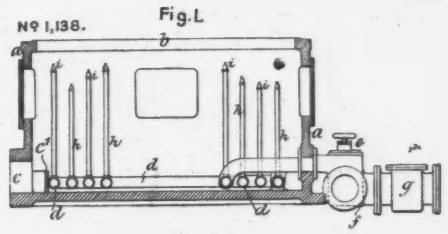


generally secure compactness. There is one figure, a section. On the under side of the main steam cylinder A is a prolongation A^1, but of less diameter, having its lower end open. In this smaller or differential cylinder A^1 works a trunk or plunger B attached to the main cylinder piston C and rod D. The top side *a* of the main steam cylinder A is in communication with the steam and exhaust ports *e* of the steam actuating valve E. The under side of the main steam cylinder piston at a^1 is arranged to be always in communication with the steam supply pipe as by a branch F, so that the under side of the main piston C is always subject to the working steam pressure. On the upward or discharge stroke of the air pump G the under side of the main piston C is subject to the steam pressure, and is available for actuating the pumps. There is only an area equal to that of the differential trunk or plunger B available for actuating the pump, and the size of this differential plunger is accordingly arranged to permit the pump G to make its downward stroke at the speed desired. For the purpose of securing greater compactness and decreasing the height of the pump the pump cover, *i.e.*, the cover H of the casing, is arranged to support the main and differential cylinder A A^1, and to form a closed communicating chamber h between the open end of the differential cylinder and the portion of the air pump above the discharge valves J. With surface condensers any leakage of steam from the under side of the main cylinder A past the differential plunger B will be absorbed by the water in the pump during its passage from the air pump G, and as this water is generally used for feeding boilers the arrangement will prevent any heat loss. The movement of the steam valve E is secured by attaching to the air pump bucket G^1 a supplementary rod K passing through a gland L on the pump cover H working on a guide L^1 attached to the steam cylinder A, and actuating through a crosshead M and levers N an attachment such as the swivel pin O to the valve spindle P, so as to move the steam valve E synchronously with the movement of the air pump bucket G^1.—*November 8th*, 1905.

CONDENSERS.

1138 January 20th, 1905.—IMPROVEMENTS IN JET CONDENSERS, William H. Allen and Richard W. Allen, Queen's Engineering Works, Bedford.

This invention has for its object improvements in jet condensers for use in conjunction with engines or steam turbines. An arrangement of multiple coils or sets of pipe for supplying water to the spraying nozzles of a condenser is employed, each coil carrying a number of jets, and the supply of water to each coil controlled by a separate valve whereby one or more groups of nozzles may be used, according to the amount of steam to be condensed by the condenser, at any time, the full number of nozzles being in action under full load conditions only. There are eight figures. Fig. 1 is a sectional elevation in which the coils are at the bottom, and provision is made for keeping them immersed in a layer of the water of condensation. The jets also are at varying

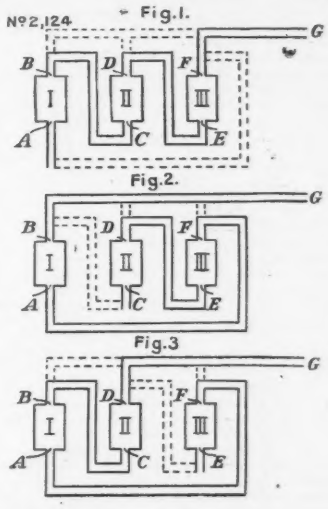


heights. The top cover is shown removed; *a* is the outer casing, *b* the stream inlet and *c* the air pump suction; c^1 is a low weir in front of the opening *c* to retain a layer of water. At the bottom of the casing *d* are four concentric rings of pipe, each supplied with water through a cut-off valve at *e*, a separate cut-off valve being provided for each ring. Water is supplied to all the valves from a chamber *f* below them. The water may be supplied to the chamber through any suitable strainer at *g* or through a pipe connected to one of its ends; *h h* are pipes extending upwards from the several rings, and each is provided at its upper end with a spraying nozzle *i*. The pipes carried by the several rings are all so disposed that each is as far away as may be from any of the other pipes, and the spraying nozzles at the top of the pipes carried by each ring are at a different level from those at the top of the pipes carried by the other rings.—*November 8th*, 1905.

GAS PRODUCERS.

2124. February 3rd, 1905.—IMPROVEMENTS IN OR RELATING TO GAS PRODUCERS, Hugh P. Bell, 3, Mincing-lane, London, E.C.

This invention relates to an improved arrangement of apparatus for the manufacture of "producer" gas and to the method of operating the same. The apparatus consists of three producers made of or lined with refractory materials connected together in series by means of tubes or passages provided with a suitable



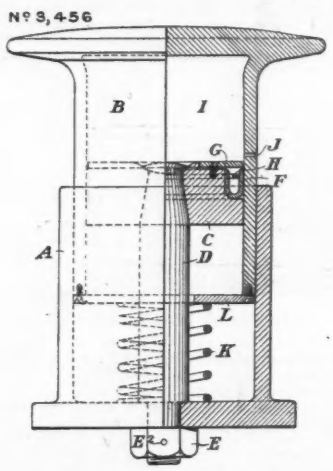
arrangement of valves, which can be so operated that while the direction in which the gases pass through the producers is unchanged, the points at which air is admitted and gases are allowed to leave the apparatus respectively are changed in such a way that each producer in turn becomes first, second and third of the series. There are three diagrams. In Fig. 1 air enters producer I at A, the gases and products of combustion leave the producer at B and enter producer I I at C, then pass by way of D and E through producer I I I and out of the apparatus by F and G. In the second stage—Fig. 2—after the first movement of the valves, air enters producer I I at C and the gases pass by way of D, E, F, A, B and out at G. In the third stage—Fig. 3—after the second movement of the valves, air enters producer at E and the gases pass by way of F, A, B, C, D and out at G. The next movement of the valves will bring the connections back into the position shown in Fig. 1. The apparatus is consequently operated in a cycle of three stages, the producers being always connected in series. The movement of the valves may be made reversible, so

that the three stages will succeed one another in the reverse order to that just described. In this case the producer to which air is admitted will in the next succeeding stage become second instead of third of the series, but there will be no change in the arrangement of the connections at each stage nor in the direction of flow of the gases. Steam is admitted in such quantities as may be required at or near A, C and E. Fuel is introduced into the producer, which is for the time being second of the series at each stage; that is to say, before the previous charges of fuel are consumed, so that as much time as possible is allowed for the distillation of the fresh fuel, and heat is generated rather by combustion of coke from which volatile matters have been distilled than by combustion of fresh fuel. The intervals between the changes are to be so regulated as to allow sufficient time for the fuel in the first producer to be heated by combustion in air, and as much time as possible for the distillation of the fuel in the second producer.—*November 8th*, 1905.

RAILWAYS AND TRAMWAYS.

3456. February 20th, 1905. IMPROVEMENTS IN BUFFERS, James F. Bennett, Gordon Cross House, Dronfield, Derbyshire; John Mastin, Foster's-buildings, High-street, Sheffield; and William Platts, Saville-street, Sheffield.

This invention consists in constructing a pneumatic buffer in such a manner that there is always a cushion of air between the plunger and a fixed piston or the like. The buffer has a hollow plunger, fitted with a piston, which may have piston rings of metal or leather packing. There is one figure, a part sectional view. The device consists of a case A, a plunger B, and a fixed piston C, supported upon a rod D, secured to the base of the case A by means of a nut E, preferably having a pin or split cottar E² passed through it. The piston C fits within the machined interior of the plunger, and is provided with a cup-leather F which rests within an annular recess in the piston, and is retained in position by a cover ring G secured to the upper face of the piston. This cup-leather

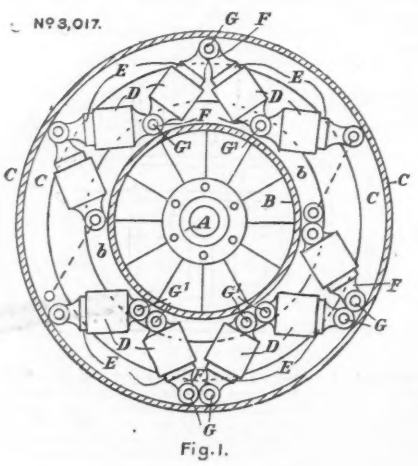


is to prevent the air when under compression from passing the piston and escaping, and it may be aided by an expanding metallic ring H. The air contained in the chamber I above the piston C will therefore be compressed and constitute an air cushion when the plunger is forced into the case; and, in order to compensate for condensation variation in atmospheric pressure and any loss by leakage, an air entrance J is provided in the side of the plunger through which air can pass to or from the interior to restore the equilibrium. When pressure is removed from the head of the plunger, the compressed air in the chamber I forces the plunger back to its normal extended position, and to aid this action a coiled spring K is placed round the piston-rod D to act against a plate L secured to the plunger, its point of resistance being the base of the case A.—*November 8th*, 1905.

ROAD MOTOR VEHICLES.

3017. February 14th, 1905. — IMPROVEMENTS IN RESILIENT WHEELS AND TIRES, Arthur D. Jenkins, Brunswick Court, Artillery-street, Bermondsey, and Daniel E. Hipwell, Burnham-on-Crouch, Essex.

The object of this invention is to secure in spring wheels radial flexibility, lateral stability and an elastic drive. There are five figures. Fig. 1 is a front elevation of a wheel with the front covers removed. Round the spokes or wood centre A of a wheel a hoop B of channel iron is shrunk or otherwise secured, the flanges *b b* projecting outwards. The hoop is at a suitable distance sur-

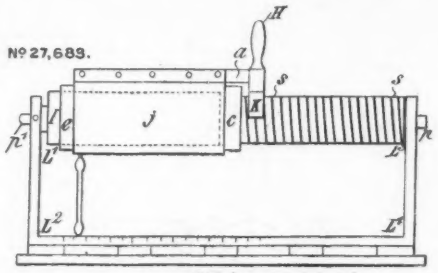


rounded by another channel iron hoop C having its flanges *c c* projecting inwards. In the annular space left between these two hoops a series of cylinders D and plungers E are so arranged that they zig-zag round the space, each alternate pair lying at opposite angles, and when the two hoops B C are concentric the axial line of each cylinder and plunger makes approximately a tangent to the circumference of the inner hoop B. The base of each cylinder and plunger is provided with a lug F that fits between the flanges *b b* and *c c* of the hoops B and C respectively, and they are pivoted thereto by the studs or bolts G G¹. It will be seen that if the hub of the wheel were pressed downward the space between the hoop B and hoop C at the bottom would be lessened, whilst the space at the top would be increased. The plungers E sliding in the cylinders D and the plungers and cylinders rocking on their pivotal attachments permit this to take place. A radial movement is, therefore, fully provided for. If a turning movement is applied to the hub A then one half of the set of plungers would be pushed further in, angular movement taking place between the hub A and the hoop C. This movement is limited by the one half of the set of plungers striking the bottom of their cylinders. They, therefore, can never become displaced or the axial line of the cylinders become a radial line. The lugs on the cylinders and plungers fitting between the flanges of the hoops and on their studs give the requisite lateral stability.—*November 8th*, 1905.

WIRELESS TELEGRAPHY.

27,683. December 19th, 1904.—IMPROVEMENTS IN INSTRUMENTS FOR THE MEASUREMENT OF WAVE LENGTHS IN WIRELESS TELEGRAPHY, Professor John A. Fleming, University College, Gower-street, London.

In space telegraphy the distance to which it is possible to propagate signals over land and sea depends very much upon the length of the electric wave used, and it is necessary to be able to measure this wave length without disturbing the apparatus employed for sending. This is done by constructing a closed oscillating circuit consisting of a capacity in the form of a cylindrical sliding condenser, and a helical variable inductance connected together so that one motion reduces or increases both the inductance and the capacity at the same time. Since the frequency in an oscillating circuit varies inversely as the square root of the product of capacity and inductance, this has the effect that the total alteration of the arrangement varies as the wave length. There are six figures. Fig. 1 is a side elevation; *e e* is an ebonite tube

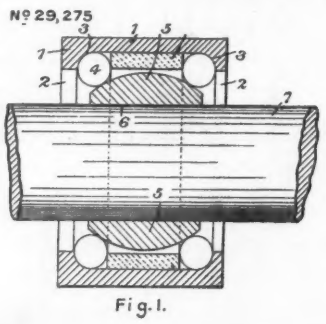


which has within it and partially projecting from it a brass tube I. This brass tube has connected to it another ebonite tube S S, on which is wound a spiral of thick copper wire which may conveniently be the size called No. 14, S.W.G. The ebonite tube on which this spiral wire is wound is smaller in diameter than the ebonite tube *e e* and fits within it. The spiral of copper wire should be wound in rather open turns, the turns being about ¼in. to ½in. apart, and the outer end of the wire is attached to a metal pin *p* fixed in one end of the smaller ebonite cylinder, whilst the opposite end of the wire is insulated. On the ebonite tube *e e* slides an outer brass tube J, which carries a bar *a a* terminating in a collar K, this collar having an insulating handle of ebonite H. This outer jacket must be of such a diameter that it can slide easily upon the ebonite tube *e e*, whilst at the same time the collar K makes good electrical contact with the spiral wire S S, the jacket and collar being moved by the handle H. The inner brass tube I has connected to it another pin p^1 and the two pins $p\,p^1$ are connected by a stout copper bar $L^1 L^2 L^3 L^4$. Thus the arrangement constitutes a condenser in series with an inductance, and when the handle H is moved along the spiral this action at the same time reduces the inductance of the circuit and the capacity formed by the two metal cylinders I and J separated by the dielectric *e*.—*November 8th*, 1905.

BALL BEARINGS.

29,275. December 31st, 1904.—IMPROVEMENTS IN BALL BEARINGS AND IN THE METHOD OF MOUNTING THE SAME, *Eugène Mathieu, Saventhem, Belgium.*

The object of this invention is to provide a ball bearing without detached parts or accessory adjusting members, and which does not necessitate use of any special means for the introduction of the balls, so that the bearing forms a simple whole, adapted to be put on the market in a form allowing of its immediate application to any vehicle or bearing block. There are five figures. Fig. 1 is an axial or longitudinal section. The bearing comprises a cylindrical box 1, provided at each end with an opening 2, and having in its interior suitable bearing surfaces 3 for two rows of balls 4,



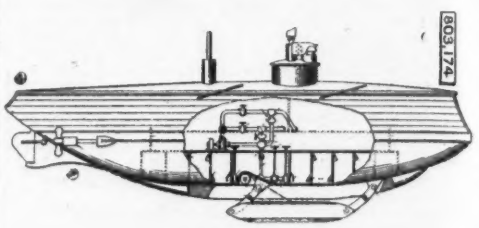
which lie against a spherical member 5, provided with a bore 6 for the passage of the shaft 7 to be supported by the bearing. The box 1 is in one piece, without any adjusting ring or other similar part, so that when the box and balls 4 therein and the spherical member 5 are placed, for instance, on a temporary rod, taking the place of the shaft, the parts constitute an easily transportable whole, adapted to be placed on the market ready for use. The lateral openings 2 of the box 1 are somewhat larger in diameter than that of the spherical part 5, so as to allow of the introduction of the latter into the box. When the bearing is mounted, the escape of the balls is impossible. At first sight, the insertion of the balls would appear to be impracticable, except with the use of auxiliary means, as in certain existing bearings. This, however, is not the case, the purpose of the invention being also to provide a bearing in which any auxiliary part tending to weaken its resistance or complicate its construction is dispensed with. Under these circumstances, it is evident that the present invention, not only consists in the construction of the bearing as above described, but also in the special method of assembling the bearing, or, in other words, of inserting the balls 4 into a box 1 provided with only two lateral openings, in which box is located a spherical member 5, of a diameter nearly equal to that of the lateral openings. One row of balls 4 is first set up in the box 1, after having closed the opening by means of a temporary stopper. The sphere 5 is then introduced into the box, the central bore 6 of the sphere being also closed at one end by a temporary stopper. On the sphere being placed in position, it is inclined slightly, so as to produce in one of the corners of the box a free space sufficient for permitting the introduction of the balls forming the second row of the bearing, owing to the presence of the bore 6 in the sphere. When these latter balls are in place, the sphere is brought back into its proper position, and after removing the temporary stoppers the shaft 7 is introduced through the bore of the sphere, which holds the latter in place.—*November 8th*, 1905.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

803,174. BALLAST DEVICE FOR SUBMARINE VESSELS, *S. Lake, Bridgeport, Conn.*—*Filed February 17th*, 1905.

This is one of four patents recently taken out by Mr. Simon Lake, the well-known American inventor of submarine boats. In this country one patent would, no doubt, have been permitted to cover the lot. That which we have selected is intended to guard



against dangerous diving. A balance weight is provided outside, as shown in the engraving, which, being raised or lowered at one end, changes the longitudinal centre of gravity. Guide planes are provided in the usual way to keep the boat on an even keel. Those who are interested in submarine navigation will do well to obtain the complete set of specifications from the U.S. Patent-office, Washington.

803,192. MEANS FOR OPERATING THE DISCHARGE VALVES OF HIGH-PRESSURE CYLINDERS, *W. P. Easton, Pa., assignor to the Ingersoll-Sergeant Drill Company, New York, N.Y., a Corporation of West Virginia.*—*Filed January 26th*, 1905.

The discharge valve at the end of the cylinder is worked positively by a piston in a small subsidiary cylinder, to which

air is admitted and from which it is withdrawn, in a way that will be easily gathered from the drawing. There are three claims.

803,258. TRACK-SANDER, *J. H. Watters, Augusta, Ga.*—*Filed June 24th*, 1905.

Compressed air from the brake cylinder is made to pass

through a reducing orifice, and so pulled down in pressure. It is passed into the sand-box, and thence escapes, carrying the sand with it, as shown. There are five claims.

803,519. PROJECTILE, *J. W. Anderson, Allegheny, Pa., A. M. Anderson, administratrix of said J. W. Anderson, deceased.*—*Filed June 27th*, 1904.

This invention is for an armour-piercing projectile having a

piercing point in combination with a frangible ring or collar arranged on the projectile, and adapted by engagement with the armour or plate to change the direction of movement of projectile and aid in its penetration. There is only one claim.

THE MEANING OF ADIABATIC.

THE object of this article is to show that three meanings are given to the word "adiabatic," and that this both confuses and misleads.

One of the three meanings that the term is used to express is that of the condition of change of a body in which the body neither receives heat energy from another body nor discharges heat energy to another body; that is, in which there is no immigration or emigration of heat energy to or from the body. If we use the word leakage to include both the immigration and the emigration, then according to this meaning of the word adiabatic, adiabatic expansion is expansion without leakage of heat.

The second meaning given to the term is synonymous to isentropic; that is, without change of entropy. Adiabatic and isentropic are used as if they meant exactly the same.

The third meaning given to the word adiabatic is that it refers to expansion or compression without leakage of heat, and without change of entropy; that is, the third meaning requires the simultaneous fulfilment of the conditions required separately by the first and second meanings.

The term adiabatic is mostly used in connection with elastic fluids. Now the expansion of an elastic fluid without leakage of heat is not necessarily isentropic; and an elastic fluid may expand isentropically although the leakage of heat is considerable.

Consider, for example, the expansion of steam past a reducing valve. After the valve and pipes have got heated up, the expansion is very nearly accomplished without leakage of heat, but it is not by any means isentropic. If the condition of the steam be measured before and after the reducing valve, this can easily be proved by consulting a table giving the entropy of steam and allowing for wetness and superheat.

The expansion of steam in a Parsons turbine is often said to be nearly adiabatic. This statement conveys no meaning unless we know what is meant by adiabatic, and the statement may seriously mislead. The expansion of steam in a Parsons turbine is certainly not both isentropic and without leakage of heat. It would be a bad thing for the makers of reciprocating steam engines if it were so, for this would mean that the efficiency ratio of the turbine—that is the thermal efficiency compared with that of an engine working on the Rankine cycle—was approximately unity.

Again, it is often said that the expansion of steam in a de Laval nozzle is nearly adiabatic. The leakage of heat may be negligible, but the writer will be much surprised if the expansion is isentropic. This would mean that there was no loss due to friction of the particles of

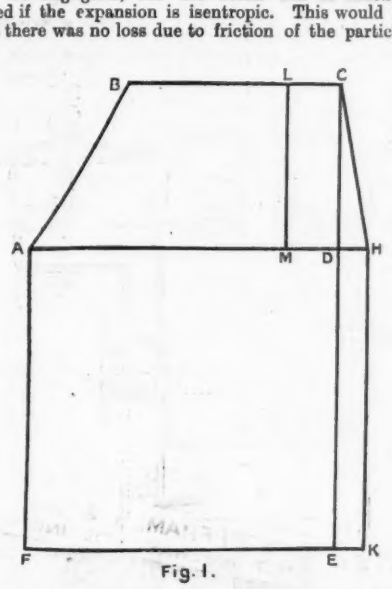


Fig. 1.

steam and water against themselves, and this at a velocity of over 3000ft. per second. If there are frictional losses within the fluid, there must, of course, be change of entropy, because the friction must heat the fluid.

A diagram may help to make the matter clear. The figure here given—Fig. 1—is an entropy temperature diagram, A B represents the heating of water, B C the generation of steam, C D the isentropic expansion of steam, and D A the compression of the uncondensed steam into water. If there is no leakage of heat then what we have is the Rankine cycle, and the thermal efficiency is the ratio of the area A B C D to the area F A B C E.

Now, suppose that the heat engine is not perfect. Suppose that the steam is expanded in a turbine in which there is fluid friction. The friction will produce heat. Some of the heat will directly leak out; the rest will be given to the steam. Let the friction-produced heat given to the steam be represented by the area E C H K. This heat is produced by work which would otherwise be given to the turbine spindle. Therefore, to get the work given to the turbine spindle we must deduct from the area A B C H, which represents the total heat converted into mechanical energy, an amount at least equal to the area E C H K. Let M L C H be the amount deducted. Then the area A B L M represents the work given to the turbine spindle.

Now, suppose, for the sake of argument, that there is absolutely no leakage of heat. Then the area M L C H is exactly equal to the area E C H K; and C H represents the expansion of the steam without leakage of heat. Now C H is not by any means an isentropic line.

This is not merely academic. If the steam passages in a turbine are designed for volumes according to isentropic expansion when the expansion is not isentropic, errors of considerable magnitude may be made.

It is time that some agreement was come to as to the meaning to be attached to adiabatic. There is a hopeless want of agreement, and a very great want of precision in the use of the word by writers on thermodynamics and heat engines, and this not only tends to confuse, but to mislead. For example, curves of compression of air in air compressors are obtained by an indicator and compared with adiabatic curves, using the word adiabatic to mean isentropic. Then the other meaning is given to adiabatic, and the nearness of the actual curves to the adiabatic curves is used to estimate the heat losses during compression. The error caused by using the word adiabatic in two senses or three senses may not be great with reciprocating compressors, where the fluid friction is small; but it is very serious with turbo-compressors. The compression curve in a turbo-compressor might quite conceivably be an isentropic one, and yet the efficiency of the machine might be only 50 per cent. Unfortunately, the ordinary indicator cannot be used with turbo-compressors to show up the error.

Professor Rankine, in a paper on thermo-dynamics read before the Royal Society in London on January 19th, 1854, and published in the "Philosophical Transactions" for that year, after describing an isothermal curve Q Q, made the following observations:—

"On the other hand, let the substance be allowed to expand from the volume and pressure V_A, P_A, Fig. 2, without receiving or emitting heat; and when it reaches a certain volume V_C, let the pressure be represented by P_C, which is less than the pressure would have been had the actual heat been maintained constant, because by expansion heat is made to disappear. Then C will be a point on a certain curve N N passing through A, which may be called a curve of no transmission. It is to be understood that during the process last described, the potential energy developed during the expansion, and which is represented by the area A C V_C V_A, is entirely communicated to external substances; for if any part of it were expended in agitating the particles of the expanding substance, a portion of heat would be reproduced by friction."

The first paragraph read by itself is not altogether clear owing to the expression "actual heat," but the inference would be that Rankine meant by a "curve of no transmission," a curve representing expansion without

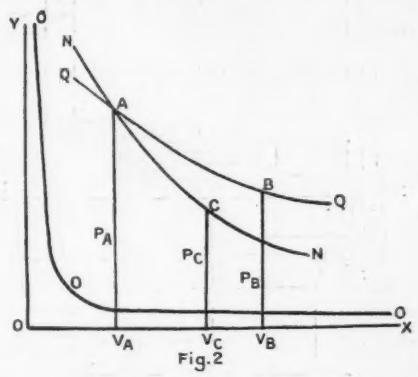


Fig. 2

leakage of heat. The second paragraph, however, qualifies the first by explaining that the expansion must be isentropic, and the meaning presumably intended to be given by the two paragraphs read together is that a "curve of no transmission" is that which represents a fluid expanding without leakage of heat and at the same time isentropically.

According to this definition a "curve of no transmission" represents something which never could occur in actual practice, even if we had a perfect non-conductor of heat, because we can never altogether avoid friction during expansion. It should also be noted that an inspection of Fig. 2 will not alone tell us whether the curve N N is a "curve of no transmission"—according to the definition just given—or not, because the figure does not inform us as to whether or not heat has leaked out and has been replaced by friction-produced heat.

In Rankine's "The Steam Engine," fourteenth edition, page 302, the following paragraphs occur. The figure referred to is substantially the same as Fig. 2.

"On the other hand, let the substance be allowed to expand from the volume and pressure V_A, P_A, without receiving or emitting heat; and, when it reaches a certain volume, V_C, let the pressure be represented by P_C, which is less than the pressure would have been had the temperature been maintained constant, because, by expansion, heat is made to disappear. Then C will be a point on a certain curve N N passing through A, which may be called a curve of no transmission or adiabatic curve.

It is to be understood that during the process last described, the mechanical energy exerted during the expansion, and which is represented by the area A C V_C V_A, is entirely communicated to an external body, such as a piston; for if any part of it were expended in agitating the particles of the expanding substance, a portion of heat would be reproduced by friction."

This is substantially the same as the definition given to the Royal Society and quoted above. Some small amendments have been made and the "curve of no transmission" has been given another name, namely, "an adiabatic." The definition of the curve is the same as before; the curve is shown on a pressure-volume diagram, and no reference is made to the facts (1) that, according to the definition given, adiabatic expansion cannot be represented simply by a curve on a pressure-volume diagram, and (2) that the expansion is such as never could occur in actual practice even if we had a perfect non-conducting envelope.

In the same volume there are other references to adiabatic curves. On page 310 occur the following passages:—

"ϕ is called the thermo-dynamic function of the substance for the kind of work in question, and in some papers the heat factor." (The word entropy had apparently not come into use when this was written.)

"The property of an adiabatic curve is expressed by $d\,H = 0$; from which it is evident, that for such a curve $d\,\phi = 0$; that is to say, for a given adiabatic curve, the thermo-dynamic function has a constant value proper to that curve."

The conclusion arrived at is in agreement with the definition previously given of an adiabatic curve, but it is not arrived at at all logically. H had been previously defined as the heat received from an external source. It does not follow that $d\phi = 0$, because $d\,H = 0$, but it does follow that both are equal to zero in adiabatic expansion, according to the definition previously given of an adiabatic. This looseness of expression characterises the writings of many able physicists and engineers when dealing with this question, and seems to arise from their using the word adiabatic before they have considered and come to a decision as to the exact meaning they attach to it.

Another example of looseness of expression is given on page 319 of the same book, where the following passage occurs:—"Heating and cooling of gases and vapours by compression and expansion: If a substance wholly or partially in the state of gas or vapour be enclosed in a vessel which does not conduct any appreciable amount of heat to or from the substance, then the compression and expansion of the substance, through variations of the volume of the vessel, will produce respectively heating and cooling, according to a law expressed by the condition that the thermodynamic function is constant."

This statement is, of course, wrong unless qualified. The thermodynamic function or the entropy is constant only if the algebraic sum of the heat which has leaked in or out and the heat produced by friction is zero.

On page 376 of the same book the isentropic requirement is completely dropped, and adiabatic expansion defined as that which occurs when there is no heat leakage. The following are the words:—"When the cylinder is either exposed—that is, not steam-jacketed—or simply cased in slowly conducting materials, such as felt and wood, the steam is assumed to expand without receiving or giving out heat, so that B C is an adiabatic curve."

According to this definition, there might be an indefinite number of adiabatics drawn through any point on a pressure volume diagram. The definition would, however, be good if it were kept to by this and all other writers.

Eight pages later, however, a completely different definition of adiabatic is given. It is defined briefly as follows:—

"The equation of an adiabatic curve is

$$\phi = \text{constant.}"$$

The no-heat-leakage requirement is here altogether dropped, and the isentropic requirement only maintained.

Here, therefore, in one book we have three different definitions of adiabatic:—

(1) No heat leakage and no change of entropy.
(2) No heat leakage.
(3) No change of entropy.

In Clerk Maxwell's "Theory of Heat" (1894), pages 127-129, the following passages occur:—

"We shall examine the very important case in which the changes which take place are effected without any passage of heat either into the substance from without or out of the substance into other bodies. . . .

"In order to represent the relation between the volume and the pressure, we suppose a curve traced on the indicator diagram during the motion of the piston, exactly as in the case of the isothermal lines formerly described. The only difference is that whereas in the case of the isothermal lines the substance was maintained always at one and the same temperature, in the present case no heat is allowed to enter or leave the substance, which, as we shall see, is a condition of quite a different kind.

"The line drawn on the indicator diagram in the latter case has been named by Professor Rankine an adiabatic line, because it is defined by the condition that heat is not allowed to pass through (διαβαίνειν) the vessel which confines the substance."

This is the no-heat-leakage definition of adiabatic. The author, however, shows in the very next paragraph that he has not appreciated the meaning of this definition, for he says:—"Since the properties of the substance under this condition are completely defined by its adiabatic lines, &c." The properties of a substance cannot be defined by its adiabatic lines, using this definition of adiabatic, because an infinite number of adiabatic lines could be drawn through any point on a pressure-volume diagram.

Professor Ewing, in his "The Steam Engine and other Heat Engines," first edition, page 46, says:—

"Adiabatic expansion: We have next to consider particular modes in which any working substance may be expanded or compressed. One very important case is that which occurs when the fluid neither receives nor rejects heat as it expands or as it is compressed. This mode of expansion or compression is called adiabatic, and a curve which exhibits the relation of P to V in such a process is called an adiabatic line. In any adiabatic process the substance is neither gaining nor losing heat by conduction or radiation or internal chemical action. Hence the work which a substance does when it is expanding adiabatically is all done at the expense of its stock of internal energy, and the work which is spent upon a substance when it is being compressed adiabatically all goes to increase its stock of internal energy. Adiabatic action would be realised if we had a substance expanding, or being compressed, without chemical

change, in a cylinder which, along with the piston, was a perfect non-conductor of heat, and was opaque to heat rays."

It is not clear whether this is the no-heat-leakage definition or the no-heat-leakage-plus-no-change-of-entropy definition. One part of the paragraph suggests the latter, while other parts suggest the former.

Professor Perry, in his "The Steam Engine" (1900), page 352, says, referring to an entropy-temperature diagram :—

"Of course, isothermal and adiabatic lines are straight, horizontal, and vertical lines."

This is not a definition of adiabatic, but it says plainly that an adiabatic line must always be isentropic.

Professor Hutton, in his "The Gas Engine," first edition, page 90, says :—

"Adiabatic expansion: The more natural and usual form of expansion takes place when there is no means of keeping up the temperature of the gas in the cylinder as it expands, but in which the gas cools by an amount equivalent in heat-units to the external work overcome by the piston when driven by such expanding gas. This kind of expansion is called adiabatic, since there is no transfer or passage of heat through the cylinder walls to the gas, but it operates by the expenditure of its intrinsic energy in overcoming the resistance."

This is, perhaps, not perfectly clear, but it appears to be the no-heat, leakage definition.

Mr. Dugald Clerk, in the first of his Cantor lectures, delivered last February, said :—

"I need hardly state that . . . an adiabatic line is a line of compression or expansion where no heat is either added to or abstracted from the working fluid."

This is not quite clear, but it seems to lean towards the no-heat-leakage definition.

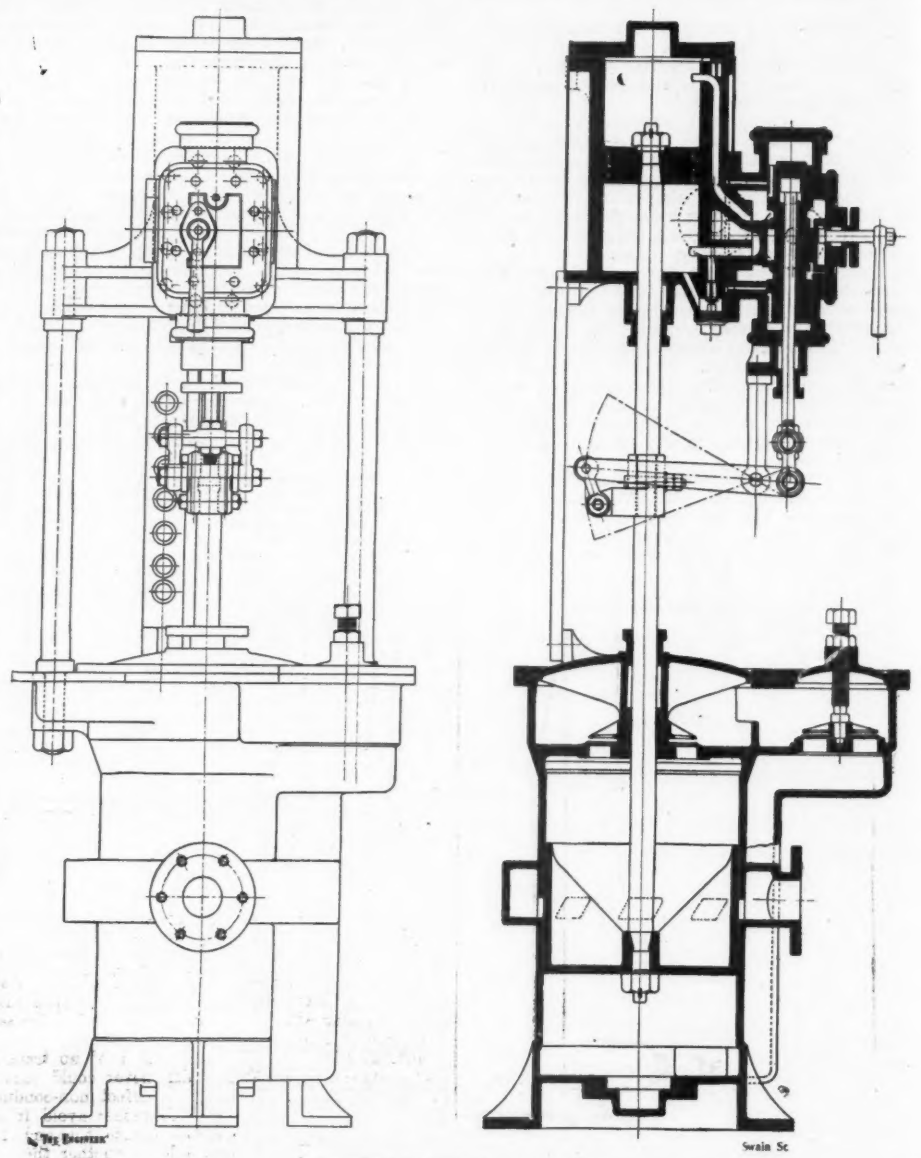
Professor Robert H. Smith, writing on "The Expansion of Wet Steam" in THE ENGINEER of October 20th, seems to use the word adiabatic as meaning without change of entropy. For example, he says, referring to a temperature-entropy diagram :—"Any vertical straight line—that is, one of constant entropy or an adiabatic."

These quotations will show the want of precision or the want of agreement among authorities on thermodynamics. It is time that some agreement was come to as to what adiabatic means, especially as turbo-machines are now coming so much into use. R. M. N.

MACHINERY AT THE NEW ROYAL NAVAL COLLEGE, DARTMOUTH.

A SHORT time ago the new Naval College at Dartmouth, for the training of junior naval officers under the new system, was opened. As necessary to this system a large and valuable collection of tools and plant has been laid down in the workshops for the teaching of practical engineering. In addition to this, and for the purpose of instructing the young officers in the practical working of the steam engine, a triple-expansion engine, with independent surface condenser, air and circulating pumps, and all necessary tanks, pipes, &c., for measuring the water consumption under different circumstances, has been installed in the engine-house. We are enabled to illustrate this installation fully herewith, and on page 585. The triple expansion engine, is of the ordinary vertical marine type, without reversing gear. The cylinders are carried by four turned and polished steel columns in front, and three cast iron columns of strong section at the back. They are 9½in., 14½in., and 23in. in diameter respectively, with a stroke of 15in., the high-pressure cylinder being fitted with piston slide valve, and arranged between the intermediate and low-pressure cylinders. This arrangement has been adopted in order to give easy access to the intermediate and low-pressure slide valves, as the engine will be used for the instruction of the cadets. The engine was required to develop 120 horse-power when running at about 120 revolutions per minute, with steam having a boiler pressure 140 lb. per square inch; but, in order to have ample margin of strength, the machinery was designed for a working pressure of 185 lb. per square inch. The scantlings, bearing surfaces, &c., are, therefore, larger than are actually required, a point of considerable advantage when it is remembered that this engine will be looked after by the young officers, and that it will be opened out, overhauled, adjusted, &c. &c., by them as part of their training. The pistons are of stamped steel of the coned type, machined all over, the high-pressure and intermediate-pressure pistons being fitted with hard gun-metal Ramsbottom packing rings, and the low-pressure piston with ordinary double cast iron spring rings. The piston-rods are of forged steel, solid with the crosshead, the slippers being of gun-metal lined with white metal, in conformity with the usual Admiralty practice for high-speed engines. The crank shaft is of steel, in one solid forging, the bed-plate being of cast iron of strong section. Metallic packing of the "Combination" type is fitted to the piston-rods and slide-rod glands. To ensure steadiness of running a large, heavy cast iron fly-wheel 5ft. 6in. in diameter and 16in. wide on the face, carried by a separate shaft supported by two plummer blocks, and coupled direct to the crank shaft, has been provided. The face of this fly-wheel is utilised to drive a dynamo by means of a belt 12in. wide. The governor is of the "Peach" type, all working parts running in a bath of oil in a case.

The steam from the main engine, as well as from the auxiliary engines used in connection with it, is condensed in a large independent surface condenser, having 435 square feet of cooling surface, the condenser being made in accordance with the latest Admiralty practice, and provided with the usual Admiralty fittings. An independent vertical air pump of the "Simplex" type, with steam cylinder 6in. in diameter, pump 12in. in diameter, and stroke 9in., is fitted, to work in conjunction with the condenser. We are informed that this pump worked in a satisfactory manner throughout the series of trials, and maintained a high vacuum. A drawing of it appears above. From this it will be seen that the steam cylinder is of the ordinary three-ported type, with a flat valve face, on which works an ordinary slide valve of the usual D class. This has been adopted in preference to the cylindrical slide valve so frequently used, as it can be re-faced many times before needing replacement, and this can be done by any engine fitter without special knowledge. The slide valve engages with, and is arranged to be operated by, a shuttle valve of the usual type, working in small cylinders at each end of the valve chest. The shuttle valve, and by its means the slide valve, is operated positively through the medium of the valve spindle, worked by the levers attached to the piston-rod crosshead. At each end of the shuttle valve are small ports, so arranged that at a certain period of its travel these are brought opposite to corresponding ports in the valve chest, the effect being that one end of the valve is put in communication with the steam from the boiler, and the opposite end is opened to exhaust. This causes the shuttle valve, and with it the slide valve, to complete the remainder of its travel by means of the steam pressure at one end, independently of the valve spindle, there being sufficient slack or play left to permit of this. As the slide valve completes its travel independently of the valve spindle, it has not to work the latter through its stuffing-box, and hence no tightening of the gland affects it. Instead of the shuttle valve being directly attached to the main slide, it operates the latter by means of a forked sleeve-piece, which can be put on or withdrawn by removing the valve chest cover. When this is taken off, the shuttle and slide valves are entirely disconnected from one another, the shuttle valve can be taken out through the end of the valve chest, and the slide valve through the slide. Thus, by means of this sleeve-piece, the whole of the valve gear can be taken out and replaced without breaking the joint between the valve chest and steam cylinder, and without disconnecting any pipes. For circulating the water through the condenser, a centrifugal circulating pump driven by its own steam engine is fitted, the engine cylinder being 4in. in diameter by 3in. stroke, and as at low tides the lift is too high for this circulating pump, a direct double-acting reciprocating pump is also supplied. This pump is of the "Duplex" type fitted with Mumford and Anthony's patented valveless steam cylinders, the diameter of the cylinders being 8in., pump barrels 8in., and stroke 8in.



INDEPENDENT VERTICAL AIR PUMP

Arrangements are made for measuring the steam consumption of the main engine, as well as that of the auxiliary engines, and also of a Parsons' steam turbine, which has been fitted for instructional purposes, and the exhaust of which leads into the condenser of the main engine above described by means of the usual measuring tanks. The order for the whole of the above installation was placed with A. G. Mumford, Limited, Colchester, and the contract time allowed for delivery of the above installation, including fixing and erection at Dartmouth, supplying and fixing all the necessary piping, &c., for connecting up to the boilers, turbine, &c., was five and a-half months.

THE SALVAGE OF SHIPS.

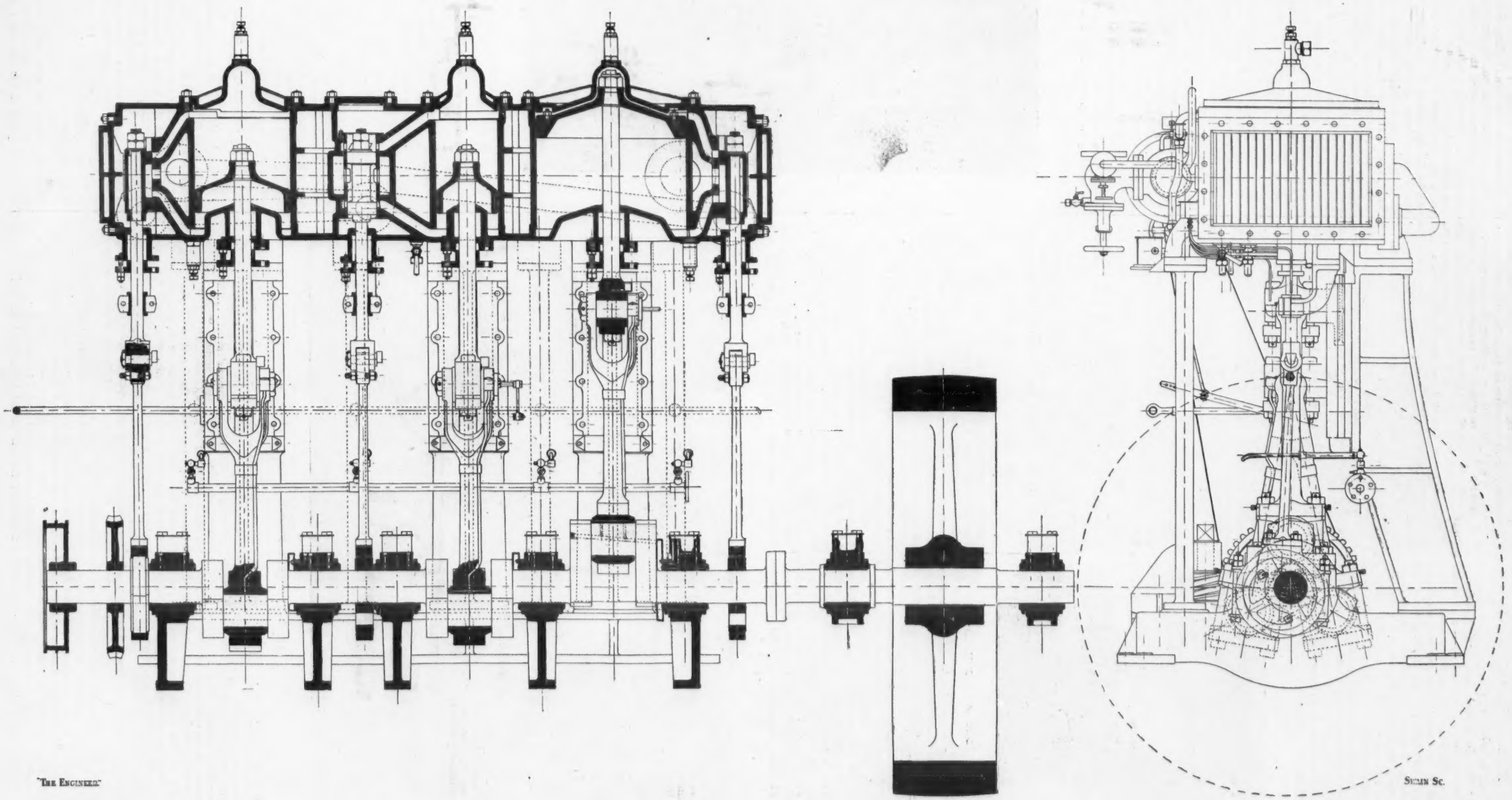
ON Wednesday, November 29th, a paper was read before the Liverpool Engineering Society by Mr. Fred W. Young, M.I.M.E., upon the "Salvage of Ships." A large number of very interesting photographs of ships in process of salvage were shown as lantern slides in illustration of the methods described in the paper. The author opened by some introductory remarks concerning the risk of salvage operations, and emphasised the importance of the commercial aspect of these. The principle of constructive total loss must, he said, be the dominating factor in the salvage engineer's calculations, and the cost of salvage plus re-instatement must never exceed the market value of the ships when repaired. Taken as a most important branch of engineering, marine salvage work had not received, in the author's opinion, the attention from English engineers it deserved, and it was only very lately that any improvement had been made in the plant and appliances necessary for this work.

As a natural consequence of this neglect of marine salvage work by English engineers, the foreigner had entered the arena, and in many places foreign salvage steamers had been stationed, and were doing work for English shipping firms and owners. The present methods of re-floating wrecked vessels were classified by the author as follows :—(1) Patching and pumping; (2) coffer-damming and (3) floating by means of pontoons. Practical examples of these three methods were next described in detail, and views of the vessels before and during the salvage operations were shown to illustrate this portion of the paper. Special attention was given to the salvage operations in connection with the dredger Walter Bibby and the s.s. Sarah Brough. In concluding his paper, the author stated that there was room for much improvement in this class of work. At present there are no means for determining exactly what stress each wire rope is carrying when raising ships by means of pontoons. The slack of each of the wires is taken in at low water as carefully and uniformly as possible, but even then one may be tighter than the others, and, as this will get the load first, it may easily be carrying more weight than its safe limit, and should a rupture take place, the consequences may be very disastrous. Failures of the kind are not uncommon. All lifting vessels should be fitted with compressors, through which the wire ropes should pass, and these compressors should be of sufficient strength to enable any of the ropes to be slacked away to an inch, if necessary, even when bearing their full weight of 280 tons. Apparently the demand in the former case could be met by attaching some sort of dynamometer to the lifting wires, so that the exact stress in tons the wire is bearing at any particular moment can be seen at a glance, so enabling them to be slacked away until each one has an equal load. No satisfactory and practical instrument of this kind was, however, known to the author. The need for a reliable and portable valve for closing the scuttle holes cut in the sides of vessels, in order to prevent them bumping in bad weather, was also mentioned. In the author's opinion, none of the valves yet tried for this work are satisfactory, and all of them prove too weak in the valve-moving part of the mechanism.

MARINE ENGINE AT THE ROYAL NAVAL COLLEGE, DARTMOUTH

A. G. MUMFORD, LIMITED, COLCHESTER, ENGINEERS

(*For description see page* 584)



"THE ENGINEER" SUTTON SC.

LOCOMOTIVE WORKS AND SHOP PRACTICE IN ITALY.

No. I.

CONCURRENTLY with the general industrial progress of late years in Italy, that branch devoted to the construction of locomotives is also taking an important position, although unaided by the many advantageous conditions which prevail in other continental countries, notably Germany and Austro-Hungary, which have hitherto been Italy's chief competitors for the home trade. Even now, on account of the high cost of imported fuel, it still remains frequently more profitable to obtain from the countries mentioned the heaviest forged work used in locomotive building instead of from large native works, as, for example, those at Terni. The commercial conditions have likewise not been very favourable to the growth of this industry, as the percentage or bonus allowed

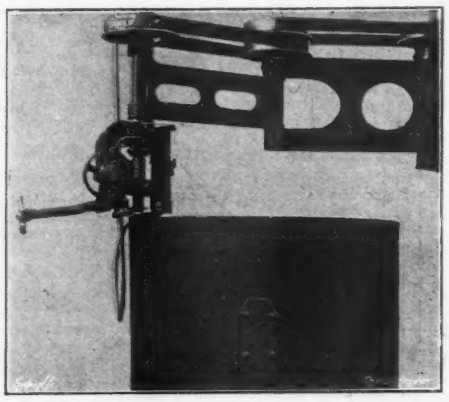


Fig. 1—PLATE EDGE MILLING MACHINE

by the two chief railway companies to the native manufacturers in the matter of international contract tenders is so small that orders have often gone beyond the frontiers when Italian firms have been underbid by a very small sum. So far, Italy has not been able to imitate the example set by France and Switzerland in the almost total exclusion of foreign-made locomotives, but contemporaneously with the operation of its own railways by the Italian Government, the State may, by acting in accordance with State operations usual elsewhere, very speedily change the ruling commercial conditions, although the example of Germany paying very high prices for its own locomotives, and thus enabling home manufacturers in slack times to export them at unremunerative prices, is scarcely likely to be imitated in Italy.

It is the greatly improved methods of its technical departments, taken in conjunction with he gradual development of the water-power resources of Italy, that have brought about the progress which is being made there. And what this progress has meant may be gathered from the fact that in the recent experience of an Italian railway company certain Italian-made locomotives have proved by the test of time to be really better constructed than similar machines by some of the best-known firms in North Germany.

The field open for the Italian locomotive builders is the home trade only, for the question of export trade is rendered very difficult by the absence of native fuel. In spite of this, it must be admitted that, notwithstanding all the manufacturing difficulties, Italy has recently advanced into territory hitherto monopolised by Austro-Hungary, Roumania, and Denmark. The success is largely due to efforts of the Breda Locomotive Company, of Milan, which possesses one of the best modern tool equipments to be met with on the Continent.

In Italy the principal firms building locomotive are:—The Ernesto Breda Company, of Milan; the "Officine Meccaniche di Milano" (better known under its old name of Miani, Silvestri and Co.); Ansaldo and Co., of Sampierdarena, near Genoa; the Officine Meccaniche di Saronno, near Milan (a branch of the Esslingan works in Germany); and Pattison, of Naples. Recently the firm of Hawthorn and Guppy, of the same city, has commenced locomotive building. Several of the smaller concerns formerly existing have been acquired by the two leading Italian railway companies, and are now used only as their railway shops; but it may be observed here that although these shops have occasionally built the first of a new type of locomotive—just as is sometimes done in Paris at La Chapelle or Les Batignolles—they do not regularly construct locomotives, and thus both the important works of the Mediterraneo at Turin and the large works of the Meridionali at Verona are devoted solely to repairs of locomotives and carriages, while the Florence works of the latter company principally turn out carriages.

The Milan shops, or "Elvetica" works of Breda are, as previously mentioned, provided with a very fine modern tool equipment. Some four or five years since this firm sent engineers to the United States to learn from the most approved practice in American shops, what tools had been found to be the best for any given class of work.

The firm's representatives made their choice, and bought machine-tools to the value of 100,000 dols., and, while securing what they considered the best individual machines of the different models selected, made a great saving on the usual cost price as paid in Italy up to that time. Since then yet other American machines have been purchased, and still more have been ordered for the new car works at Sesto San Giovanni, to the north of Milan.

It will very naturally be said that better might have been done by purchasing the tools in England; but it may be remarked that at present the prevailing idea on the Continent is to lay down all American tools, or, when this is not possible, to buy European tools made from American models. Most, if not all, of these modern tools being well known to engineers, the mention of those which are actually employed in continental shops may at least serve a purpose in acquainting English tool makers of the models which meet most favour with European locomotive builders.

Plate-working and boiler shops.—The greater part of the tools in this department are of English origin, being all of those types which cannot be excelled for solidity and lasting durability, such, for instance, as rolls for plate planishing, straightening and bending, machines for shearing, edge or lateral planing, punching, &c. The only one of these tools which is not common in every continental locomotive shop is a boring machine with

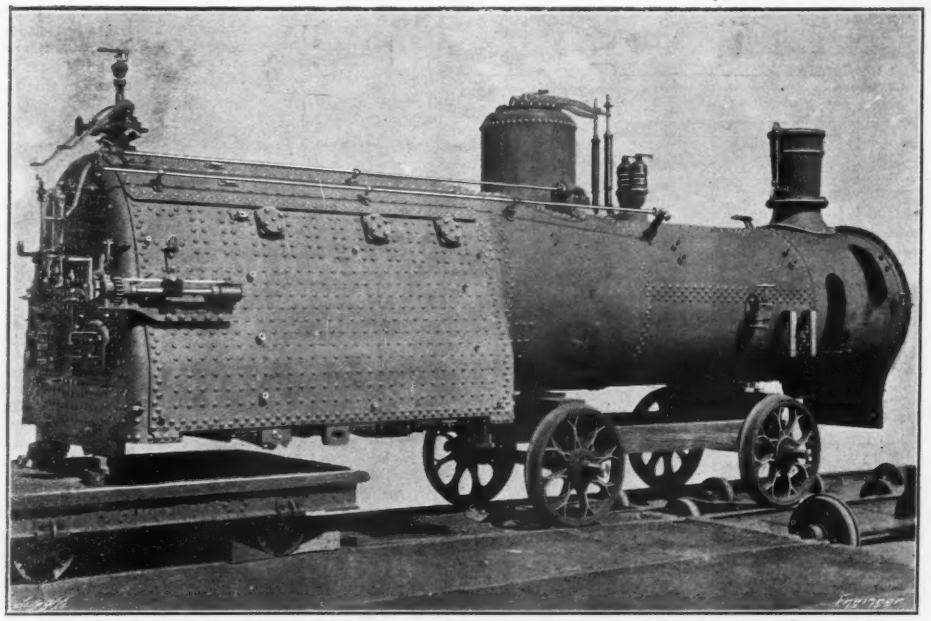


Fig. 2—COMPLETE ITALIAN BOILER

revolving bed-plate by Kendall and Gent, and used for cutting out holes in assembled boiler barrels. When, as sometimes happens, the boiler rings are not chamfered before binding up, the ring—after being temporarily bolted—is placed vertically in a floor pit below a radial milling machine made by Langbein, of Saronno, near Milan, the thin milling cutter of which automatically follows the inside contour of the ring until the sheet is cut right through and the piece comes off as a rind, leaving the plate with the desired fullering edge. The general arrangement of this machine can be distinguished in the view, Fig. 1. It is to be found in many other continental works, and serves also for milling the lower edges of the back and front (throat) plates. This type of machine appears to be found very useful. All the flanged plates just enumerated are forged in the adjoining smithy, together with the circular tube plate. This latter is flanged from a square sheet, the projecting angles being afterwards cut off in the lathe while the inside and the outside flanged edges are being turned up, which is all done at one chucking.

The various dies for all flanged work are cast in the works foundry, and the hand flanging of plates works out at less cost than for the imported pressed plates, after allowing for Customs duty thereon. Hydraulic presses are not used in these shops, and even if these were available, the continual increases in the dimensions of locomotive fire-boxes, and the comparatively few locomotives which are ordered at one time, would not warrant the making of the expensive top and bottom dies required for them. This is the experience met in other continental shops, where even with a full installation of presses a great deal of hand flanging is still done. Nevertheless, in the remodelled works of the firm, a complete hydraulic and pneumatic plant is to be installed. The boiler-erecting shop is provided with twelve portable drilling machines, run by electro-motors of from 2½ to 3½ horse power, from Oerlikon. These are employed for drilling and reaming after the component rings of the boiler are "basted" together. A particularly fine tool is used for drilling, reaming, and tapping the fire-box bolt-holes, and also for screwing home the copper stays, as well as cutting off the protruding heads of the iron crown bolts. This machine is made by Collett and Engelhard, of Offenbach. The milling cutter used for this latter work is really a small circular saw 4¾in. diameter, which cuts off the crown stay bolt ends at about the rate of one in ten minutes, according to the angle required by the contour of the fire-box shell. This machine carries its own motor of 3½ horse-power, and the drill mandril can be set at any desired angle, vertically or horizontally, or the drilling head adjusted for any height on the standard, which itself pivots on the carriage on the bed-plate, along which the standard or upright travels, until

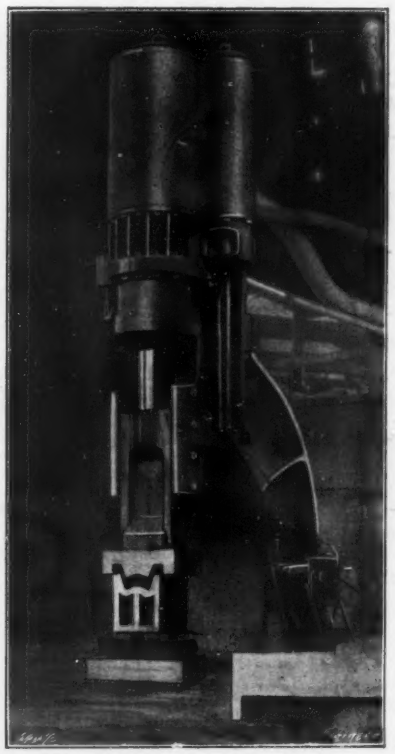


Fig. 3—HYDRAULIC PRESS

the whole row of stay-holes, or stays, has been completed.

The methods of assembling the boiler plates present no features differing notably from the usual practice of continental shops, but the work to be done is very different for the various boilers of the large locomotives in course of erection for the principal Italian railways. For the Meridionali—or Adriatic—railways the longitudinal boiler seams are butted and double cover-strapped, and the fire-box copper stays are always drilled down to the water space at each extremity. In the "Mediterraneo" boilers the longitudinal seams are always lapped, and the copper stays are of solid pattern. All copper stays are cut to the exact length required, so that there is no wasteful after-cutting to be done at the boiler, as is common enough in France and Switzerland. In the view Fig. 2 is shown an American-type boiler, finished and being transported from the boiler shops to the erecting shop.

Although the shops are provided with a hydraulic riveter, most of the boiler riveting is done by hand, as, too, is the framework riveting. At one end of the building are situated the furnaces for heating and for annealing the barrel rings after they have been bent up and riveted, this reheating being prescribed in some of the specifications. Hydraulic testing of boilers and cylinders is effected in presence of the railway companies' engineers in another part of the same shop before the fire-box stays have been riveted over, so as to reveal any leakage, and in the heat test—after riveting—the boilers are fired up anywhere that is convenient in the middle of the bay, the smoke escaping through the clerestory of the roof. The old boiler shop has now been removed to an annexe, which at present is one of the best boiler shops in Italy. It is in the place of the old boiler shop, the old foundry,

and the old smithy, that this new forge department has been created.

Smithy.—The smithy is old, and hardly in keeping with the rest of the works. There are here nine steam hammers sufficiently powerful to forge the largest run of work of the kind that is usually done in continental locomotive works; that is to say, all the rods for the motion, weigh-bar shafts, brake-lever shafts, driving-axle boxes, &c. Circular cold saws are used for cross cutting bars, bolts, &c.

Since the notes for this article were made, several departments of the Breda Works have been transformed. The smithy has been enlarged to three times its former area, and has been made into a shop of modern proportions, and during the present year has been installed with a suitable equipment. Of the new tools, the most noteworthy is a rapid-action hydraulic press, worked by steam, making sixty strokes and over per minute, and exerting up to 800 tons pressure. It was specially made for these works, and is suited for all-round forging, pressing, and die work. As shown by the accompanying view, Fig. 3, it is of the form usual for small steam hammers, with an upright or frame of steel castings—or moulded steel—the shape of this part lending itself to the operations of turning the pieces being forged. In front of the machine is the large single-acting steam cylinder, or transmitter, its piston-rod forming a plunger in the hydraulic ram attached to the crosshead. The steam pressure in the large cylinder is 90 lb. per square inch, and the pressure which it generates, in the short hydraulic cylinder below it, is 4500 lb. per square inch. On one side of the machine is a steam-worked hydraulic accumulator, the water cylinder of which is connected at its upper end with the highest part of the main hydraulic cylinder. The general water-service supply of the works is connected to the bottom of this auxiliary hydraulic cylinder by the feed pipe visible in the view. This accumulator provides the low-pressure water for the light working of the hydraulic ram and its attached forging block; as, for instance, in operations for setting the stroke.

In the rear of the main steam cylinder, or transmitter, is another single-acting cylinder, under whose piston the steam pressure is continuous, and which at once lifts the hydraulic ram and its connection the moment that steam is cut off from the transmitting cylinder. The piston-rod of the lifting cylinder is bolted on the back of the massive crosshead, and is therefore not visible in the engraving. When the lifting piston is pulled down by the stroke of the ram, the steam is simply forced back into the boiler pipe. The advantage of the arrangement is that there are no valves acting under heavy pressure. The only valve is that one on the main steam cylinder—transmitter or compressor as it may be called. This is of the double-beat balanced-valve pattern, worked by a powerful hand lever, visible in the view. The hydraulic pressure can be varied to any extent up to the maximum, by means of the steam piston returning to make a fresh stroke, the hydraulic ram below descending each time about 4in., and within the total stroke-limit of 2ft. As the piston or plunger ascends, the auxiliary compressor or accumulator forces low-pressure water into the hydraulic forging ram. This press gives much satisfaction for locomotive work in general.

There is a large annexe for coppersmiths (about 150 men), sheet-iron moulders (for boiler sheathing, cabs, &c.), a brass foundry, and a tube shop, wherein iron tubes are provided with copper ends, the operations performed here resembling those done in most other works. At the end of the smithy is a reheating oven for purposes of hardening forged pieces. The smaller parts are heaped into an iron box, and when at the right temperature this latter is run out along an aërial monorail to the yard, and then dumped with its contents into a tank of running water.

Foundry.—This is of small size, but it suffices for the heaviest casting work that is required for locomotives, such as, for example, the very large groups of low-pressure cylinders, with their cylindrical valve chests, for the four cylinder compounds of the Adriatic railways. These cylinders, with their crossed steam passages, are moulded, run, uncored, and cleaned without appreciable difficulty, and an examination of the machined work shows it to be very fine and free from flaws of any kind. Out of twenty-eight pairs of cylinders, having one cylindrical valve chest cast with each couple of cylinders, and made during the present year, only one casting exhibited a flaw. The moulds are made in the shop floor with special bond mixtures, then well rammed, covered with fine sand, and painted with graphite as usual. The large cylinder castings previously mentioned are dug out a couple of days after pouring, and are then allowed to cool slowly. Blast pipes cast here are mostly of the Adams type, or modifications of this.

The large oval forms required for flanging the ends of the new type of cylindrical tenders used in Italy are also cast in the foundry, together with those required for flanged work of wide-type fire-boxes. Steel castings are mostly obtained from the noted steel works of the Fonderia Milanese d'Acciaio, including bolsters for bogies, frame braces or tie frames, and also the skeleton boxes or brackets for the motion. The use of steel castings in locomotive construction is extending, and in the case of the Mediterranean locomotives it is largely employed in the make-up of the frames. A large new foundry has taken the place of the car works, now removed to the environs of Milan.

Heavy machine tool shops.—One of the principal shops is devoted to the machining of cylinders and frames. The cylinders are bored upon a cylinder boring machine, made by the Niles Tool Works, which bores all sizes up to 850 mm., or 31in. A new cylinder boring machine of novel type has just been built by the firm. The cylinders for four-cylinder locomotives are rough-bored on the American machine, and then permanently bolted together—two horizontally and two (inside) inclined—and all four bores finished off simultaneously, and as in a jig, upon the new machine, which has the four boring heads bolted to a heavy foundation plate.

All the plane faces of the castings are dressed upon a well made milling machine, by Güller and Züst, of Intra (Lake Maggiore). The traversing slide of this tool gives a useful rise over the bed of 5ft., it has also a clearance of 5ft. between the sides, and the bed has a travel of 12ft. The largest group of two cylinders made at Breda's can be entirely milled throughout upon this machine. The stud bolt holes are drilled and tapped on a machine of the well-known Dixon's pattern, the whole series of holes for a large cylinder, including valve chest and frame bolts, being completed in twenty hours.

The frames, which are first slightly surfaced under an emery wheel, are slotted upon a triple-headed machine with a 36ft. bed from the Saxon Engine Works of Chemnitz. Eight plates 1¼in. thick are machined at a time, and for curves or corners one hole is bored to start the cut, the tool then being directed by hand, and after the pieces have been slotted out roughly and the plates have undergone any changes or deformations due to the work upon them, they are then marked off afresh below a standard template, and finally finished off upon the same machine up to the scribered line. This shop is served by a 15-ton overhead travelling crane by Cerimedo and Co., Elvetica works.

The practice of employing milling machines is very extensively followed in these works, and it is found to be economical and speedy, although the cutters used are not always simple in their forms. Three large bays are closely packed with milling tools arranged in rows. The makers of most of these milling machines are Züst, Kendall and Gent, Craven Brothers, Breda, and also the Grafenstaden Company, while some are by the Ingersoll Milling Machine Company. The cutters employed in the latter machines will work up to a width of 12in., the beds being 24in. in width. Slide bars are usually of hard steel, and hence do not always require to be hardened and ground. The diamond-section bronze bushes, in two pieces, for certain guides or supports of slide-valve stems, are milled at one cut by a V-milling cutter giving the exact form required.

Axles are generally obtained from Krupps and from

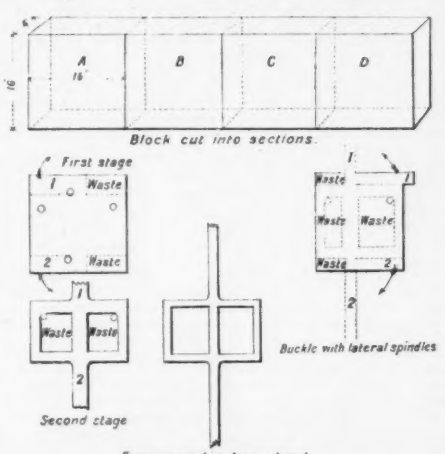


Fig. 4—MAKING A VALVE BUCKLE

Bochum, and the tires occasionally from Cammell, Laird and Co., Sheffield. The main driving-rods and coupling-rods are of Siemens-Martin steel, and these, as well as the weigh-bars for the reversing gear, are entirely machined by milling, including, of course, the fluting; while the foundation rings are milled over on every side upon a heavy machine specially made for this work. The mud-ring, when for engines of the wide fire-box type, is forged with projections, or expansion brackets, on the front and back ends for resting on the edges of the engine frames. For milling the oblong cotter-holes in main-rod big-ends and in coupling-rod ends, a Smith and Coventry machine is used, its cutters commencing at either end of the slot, and then advancing towards the middle. Large valve-buckles are sawn out as near as possible to the required shape, in order, principally, to save the cost of forge fuel, which is high, and thus a buckle can be manufactured without the usual weld in its cheeks. This operation is explained by the sketches, Fig. 4. A slab of metal of about 16in. wide by 4in. thick is sawn up into blocks, A, B, C, D, of from 16in. to 30in. in length, each slab weighing about a quarter of a ton. At one end of each block a couple of pieces are first sawn out to waste, and two 1⅜in. holes are drilled through the opposite corresponding ends; a saw cut is then run down as far as these holes, the outer scarfs, "1" and "2" only remaining to be bent outwards at right angles to form the nucleus for the valve-buckle spindles. Previous to this being done two more holes are drilled near the middle length from which to start the saw for the cutting out of that part which is to receive the valve. The various sketches show how this is done and how the valve buckle stems are eventually drawn out, leaving only the middle rib to be sawn away in the last operation. The total time required for each piece at the saw is about six hours. The band saw used is by Massey, of Manchester, and serves for all kinds of cold work.

In fitting valves a slight clearance is always allowed between the valve buckle and the flanges of the valve, in order to admit of the valve being lifted from its seating in event of excessive compression occurring in the cylinder when an engine is reversed against steam, or when too much water collects in the cylinder.

The painting shop is now quite new, well built, with a north aspect for the roof lights, of shedding pattern; it has asphalt floor, steam heating, arc and incandescent lights, and houses three of the longest locomotives and tenders of Adriatic type. With the various improvements made in the Elvetica Works, and which will all be complete for the Exhibition year—1906—the shops are typical of the advance made by industrial Italy in recent years. Their field of action has recently been extended to gas engines, and also to traction and ploughing engines.

CONFERENCE ON SMOKE ABATEMENT.

In accordance with an announcement which we published some time ago, a Conference on Smoke Abatement has been held at the Royal Horticultural Society's New Hall at Westminster during this week. This Conference, which opened on Tuesday evening and finishes to-day, was arranged by the Royal Sanitary Institute and the Coal Smoke Abatement Society. In conjunction with the Conference an exhibition of apparatus, which included grates, stoves, cooking plant, heating flues, chimney construction, and smoke consuming and preventing appliances was held.

Before going on to the actual work of the Conference it may, perhaps, be as well to glance briefly at the objects and work of the Coal Smoke Abatement Society. It was formed in 1898 to further the aims, as it says of itself, "of those who desire a cleaner London." Its sphere of action is mainly limited to the metropolitan area, and its objects are:—

(*a*) To aid in enforcing, through the local sanitary authorities, the existing law dealing with smoke nuisance, which is contained in the Public Health (London) Act, 1891, and the Public Health Act, 1875. For this purpose it employs inspectors to make observations of smoke nuisances, which it reports to the proper authorities. The number of such reports to the end of the year 1904 was 7444.

(*b*) To promote and encourage all voluntary efforts to abolish smoke from the flues of dwelling-houses, and to inquire into the best means of effecting this object.

(*c*) To obtain evidence of the best methods of dealing with smoke nuisances at home and abroad.

(*d*) To publish information on questions relating to smoke nuisances and the methods by which it may be abated, and for that purpose to encourage the organisation of exhibitions and stimulate invention by the offer of prizes.

(*e*) To bring about the amendment of the present law where it is not efficient.

From the Society's report for 1904 we learn that during that year, at the instance of the Society, an application was made to the Secretary of State for Foreign Affairs for particulars from his Majesty's representatives as to smoke legislation abroad, with the result that a complete return has just been issued, upon which the committee hopes to build important conclusions for use in the immediate future. In the report of the chief officer of the Public Control Department of the London County Council for the year ending March 31st, 1904, stress was laid on the efforts of the Society to secure a diminution of domestic smoke by experimental tests of various forms of grates. The same report records an increased activity of the Borough Councils, with the result that during the year in question 569 notices were served on offending works, and 51 convictions secured against those who neglected to comply with these. A supplementary report of the Meteorological Council on London Fogs, alluded to in the Society's previous year's report, has been issued. Its recognition of the Society's work, and its insistence on smoke being the main cause of those fogs which are bad enough to interfere with river traffic, have encouraged the Society to request the Port Sanitary Authority to receive a deputation on the subject, and that authority, which is showing great activity and interest in the matter, has readily consented.

"This recognition by Public Departments of the outcome of the Society's efforts is," says the Society's report, "peculiarly satisfactory because, so long as the law remains as it is, we have to rely for pure air and atmosphere upon public opinion and the sympathy and energy of the Local Authorities, for, unfortunately, if the Local Authorities choose to defy the law and neglect their duty they can do so with impunity. The Department of State which the people of this country have entrusted with the duty of compelling Local Authorities to enforce the Public Health Act, itself sets the example of disobedience in persistently refusing to exercise the powers which Parliament has placed in its hands."

As an instance for the necessity for such an organisation as the Coal Smoke Abatement Society, the report mentions the increasing numbers of the applications to the Society for information and advice, not only in this country, but from all parts of the world, the last being from Vienna. At home special attention has been drawn to the smoke nuisances in Canterbury. The diminution of the evil in certain areas in which the Society has worked systematically, and where the local authorities have recognised the possibilities of the powers at their disposal, has become so conspicuous that the Society decided to apply for a return from manufacturers within these areas where chimneys have ceased to offend. The answers have been most full and courteous, and the result is that the Society has now in its possession a mass of valuable information founded on actual experience of practical men, which seems to open up new lines of action that can scarcely fail to give a new impetus to the work.

The result of the year, therefore, seems, continues the report, to be eminently satisfactory, and the possibilities of the future great. Notwithstanding all this, it is to be regretted that the difficulty of inadequate funds still continues. From January 1st to December 31st the Society's Inspector reported 1550 observations of smoke pollution, which led to the detection of 988 cases of nuisance, and upon these observations 949 complaints were forwarded to the various Local Authorities within the metropolitan area.

From the foregoing it will be seen that the Society claims to have done a great deal in a short time, and it would doubtless have done more had funds permitted it. People complain enough about fogs, but are not so willing to find money wherewith to combat them.

What encouragement the Conference may have received from the heavy fog that had hung over London in the early days of the week was rather damped by the

failure, through illness, of the Duke of Fife to perform the opening formalities, and of Sir Oliver Lodge, from a similar cause, to deliver a lecture on "The General Problem of Combustion Reform." The chair was taken by Sir William Richmond, who, in his opening address, looking at the question of a smoke-laden atmosphere from the artist's point of view, wished, we gathered, to penalise broadcast every manufacturer in every part of the country who permitted smoke to issue from his chimneys. That the householder also offended he did not deny, but every reform had to be started by an onslaught on some particular point, and it was far easier to get at the manufacturer than the private consumer. The address was not uninteresting, but it was a reformer's address—it exaggerated the facts, and in a sense it was partisan. It was the artist speaking for art treasures, and forgetting that, great as art is, there are matters of far more consequence that must be considered. All jeremiads against the production of smoke are fruitless compared with the influence that would be exerted by infallible testimony that the manufacturer could save money by burning instead of discharging into the atmosphere the carbon from his furnaces. This was the view that it was hoped would form the basis of Sir Oliver Lodge's address; but, unfortunately, as far as one might judge from the abstract of it which the chairman read there is no immediate hope of bringing conviction of the kind home to the manufacturer. Sir Oliver admits that the luminous flame, the flame that radiates heat, is the best flame in a boiler furnace. Heat, he says, cannot be directly transmitted by flame to a cold surface. As soon as burning gases strike a body of much lower temperature than themselves they are extinguished, and a layer of unburnt gas separates the flame from the cool surface. Radiant heat is more efficient, and perfect combustion with a non-luminous flame is therefore not desired. As long, therefore, as coal is burnt in boilers, smoke to some extent must be expected. The cure, the radical cure, lies in the prohibition of general coal burning. Sir Oliver supports the old suggestion that coal should be burnt only in the neighbourhood of the mines where it is raised. It should be reduced to coke, which is invaluable for smelting, and the gassy products, after purification, should be conducted in pipes to every power user and every domestic hearth. Gas fires—it is not denied that they require to be improved—should be alone permitted, and the gas engine should be encouraged and developed.

The immensity of such a scheme of gas production is the best commentary on it. It is obviously impracticable. Some plan more easy and more likely to be realised must be discovered if the production of domestic smoke is to be obviated. The gas fire supplied from local sources may do much when the objections to them have been removed. We were surprised that another plan, which has much to commend it, did not receive consideration by Sir Oliver Lodge. We refer to the distribution of steam and hot water for heating purposes, a method which has much to commend it for the warming of cities.

After Sir Oliver Lodge's address had been read, Mr. W. N. Shaw, Director of the Meteorological Office, delivered an instructive lecture on "London Fogs." Mr. Shaw's remarks, also, must have come somewhat as a disappointment to the more eager members of the Smoke Abatement Society. Investigations have shown that physical causes over which we have no control are responsible for 80 per cent. of fogs in large cities, and it is a melancholy fact that the agents of these causes are the open places and parks. On clear nights radiation takes place rapidly from such areas as are open to the sky; the temperature falls rapidly, the dew point is reached, the moisture in the atmosphere condenses, and a fog is formed. It rolls from the place where it is generated to those which lie lower, and its room is filled by incoming air, which in its turn is chilled and converted to fog. Where there are buildings fogs are not generated, and the cure for such mists as these lies in the enclosure of all open spaces and the destruction of our parks. Probably it is better to tolerate the few days of fog.

There remains, however, to comfort the smoke abater, 20 per cent. of fogs which Mr. Shaw ascribes wholly to smoke. He did not say how, and left his audience in the dark on the very point that needs enlightenment. If smoke alone can produce fog, then fogs should be far more frequent than they are. Probably all that smoke can do is to blacken a fog once formed by natural means. It may, we think, be safely asserted that if all the smoke in the whole county of London were collected into the three miles radius it could not unaided produce such a blackness as visited us on Monday last. Smoke, however, as Mr. Shaw pointed out, has another malign influence. It is recognised that many of our densest fogs are not deep, and it is probable that the rising sun would find little difficulty in dissipating them had it a fair chance. Unfortunately a cloud of smoke rests, not improbably, upon the surface of the fog, and being very impervious to the sun's rays, prevents the warming of the air that would otherwise remove the mist.

No doubt there is a good deal of force in that argument, but after all is said and done, it would appear that particular London fogs are not likely to prove a very useful lever to the smoke reformer, and he will find more help from the general smoky mist that surrounds great and the general vitiation of the atmosphere at all times and seasons.

On Wednesday morning there was a good attendance present to hear the discussion on a series of papers on the subject of "Domestic Smoke Abatement." The Chairman for the day was Sir Geo. Livesey, and the proceedings commenced with his address, of which the following is an abstract:—

To induce an individual to change a long fixed habit or practice is a very difficult matter, unless it can be shown to be decidedly to his interest and advantage. But there is hope for London; the abatement of its smoke has begun. To estimate the proportion of the smoke of London due to domestic fires is impossible. It is certainly very large and greatly in excess of that produced by factories, &c. On a still day even a few cottages will fill a country valley with smoke, and I often see from a hillside overlooking the lower part of a town the great amount of smoke from a few hundreds of small houses. In fact, if domestic smoke could be abolished, that from factories would be found to be less than is commonly supposed, and would cause little trouble. Gaseous firing, gas engine, and the dynamo are potent agents for the diminution of factory smoke.

If—and it is certainly a big "if"—a suitable gaseous fuel, at a low price, could be substituted for the bituminous coal now used so largely, the trouble would be ended. The improvement that has taken place during the last twenty years—much more in the later than in the earlier ten years—is due to the substitution of gas for coal by the general adoption of gas cooking stoves by all classes and particularly the wage earners.

Within the last ten or twelve years, by the introduction of the penny-in-the-slot meter, almost the whole of the wage-earning classes of London have been supplied with gas, whereas previously not one in a hundred used gas, for which there were two reasons—the cost of fitting up their houses, and the periodic collection of the gas accounts.

It is safe to say that of the 834,000 consumers supplied with gas by the three metropolitan gas companies at least 80 per cent., or 667,000, use gas stoves for cooking. From the King's palace to the cottage or the small tenement of the workman, from the small room occupied by a single man or woman to the largest business and other establishments where hundreds are fed daily, gas is used for cooking. The demand for gas cookers is still maintained, these three companies supplying not less than 700 to 800 a week, and if the other companies in the immediate suburbs are included, the new cookers fixed in all London must average about 1000 a week. Substitute coal for all this gas, and what would be the condition of London!

There remains a more difficult task for the advocates of smoke abatement, on which, if they are to succeed, they must concentrate their attention. The domestic fire used for heating is the problem. It needs extreme care, suitable appliances, and expert knowledge to burn bituminous coal in a steam boiler or factory furnace generally, without smoke. It is vain to expect such a combination in the case of the domestic fire, though it may be improved. Coke, no doubt, is best when used in closed stoves, and at the same time very effective, and anthracite can only be so burnt. Abroad closed stoves are common, but England will have none of them for the heating of sitting-rooms. We have been too long used to the cheerful open fire—which, in addition to its cheerfulness, serves another most useful purpose, as a ventilator—to give it up without good reason. Constructed as our houses usually are, we have to depend for ventilation on the chimney. I have had a number of experiments made in eight different rooms, which show that in ordinary dwelling-houses the chimney, when the fire is burning, will take away about five times the cubical contents of the room in an hour, in some cases slightly less, and in others considerably more. Gas fires are often so placed as partially to block up the chimney, and thus check the flow of air, which is probably the reason why complaints are sometimes made against them. This, however, can be, and is, in many cases, avoided. The chief objection to gas for heating is that it is more costly than coal when the fire is required throughout the day. Therefore, the inhabitants of our towns will not adopt gas generally, even to please the Smoke Abatement Society. Give them as efficient heating as convenient, and as cheap as the coal fire, and they will in time adopt gas generally. As to convenience and cleanliness in the house, gas has a great advantage over coal, which is one point in its favour.

The great desideratum for smoke abatement is cheap gaseous fuel. Fortunately illuminating gas, thanks to the Welsbach mantle, is no longer necessary, heating power being the only requirement. To use gas with a luminous flame burner is now nothing less than unjustifiable extravagance. Over 80 per cent. of the consumers use the mantle, and in a short time it is hoped that it will be as difficult in England as it is in Germany to find a flat flame burner in use. This being the position, there is no real obstacle to the supply of one quality of gas for all purposes. Now an eight-candle gas would answer all purposes. An entirely non-luminous gas would do, but that there are passages and cellars and other out-of-the-way places where a small light is necessary, and this can be better obtained by an ordinary burner than by the use of a mantle. There are, however, two difficulties in the way. In London the County Council have put every possible obstacle in the way of all the gas companies' efforts to obtain parliamentary sanction to reduce illuminating power, and in the meantime the production of cheap gas suitable for all purposes is delayed. The gas companies have no monopoly now, but are subject to fierce competition. If they do not supply the article the consumers want they lose business. The restrictions imposed by Parliament, when they had an absolute monopoly and gas was the only practicable artificial light, are now not only useless but mischievous, because they stand in the way of the production of cheap gaseous fuel, which I believe to be the great desideratum for the prevention of smoke.

The second difficulty is that we have not yet found the gaseous fuel suitable for the purpose, which can only come by slow degrees. We want freedom to work in that direction. It is by these means that, in my opinion, lies the best hope of success in the abolition of smoke. It can only come by providing the public with means to supply their needs for heat and light that will suit them better than those at present available. The domestic fire is the point to attack, and this will not be given up for sentimental reasons. No householder will give up his coal fire simply to prevent a smoky atmosphere, but if an efficient and cheap substitute can be found then a gradual change will be made. Legislation to control the householder in this matter is futile, and I hope the Sanitary Institute and Smoke Abatement Society will not follow the Socialists in the belief that everything can be done by Acts of Parliament. As much freedom as possible is what we want if we are to progress, but put not trust in legislation, which means restriction.

The Chairman, when he had concluded his address, announced that the papers would be taken as read, but in order to allow the authors to supplement their remarks they would each be allowed five minutes before the discussion was opened. This allowance of time was greatly exceeded, with the result that the discussion proper had to be limited to about half an hour, and, as there were several speakers, their observations were so limited that they were of little practical value.

The first paper was by Dr. H. A. Des Vœux, and was entitled "The Abatement of Smoke from Private Houses." Of this the following are a few abstracts:—

For more than five hundred years coal has been brought to London for consumption in fires, and for all that length of time smoke has been added to the atmosphere; and it was not imagined that the amount of smoke could be diminished either from factory or domestic chimneys, and no other satisfactory method of heating was tried, or perhaps known. With this opinion predominant, it was not remarkable that the atmosphere of our city was polluted, and that the pollution should increase until people thought that the smoke was not an extraneous, but an essential part of the air we breathe, and therefore in no way to be avoided, that to remove it was as impossible as to remove the Thames, and that those who tried to do so were lunatics, seeking to square the circle or flatten the earth.

It is now my duty to point out some means by which smoke from private houses can be avoided. For the last eight years I have studied this question pretty deeply, and have made numerous experiments in my own house. It was evidently necessary to see what could be done to improve coal fires, and with this object the Coal Smoke Abatement Society—to whom every assistance was given by His Majesty's Office of Works—carried out two series of tests. A further and much larger series of tests has just been carried out in the new Government offices in Great George-street, under the able superintendence of Sir Henry Tanner, principal architect to the Government, in conjunction with a small sub-committee of the Coal Smoke Abatement Society. Broadly speaking, it may be said that there is no such thing as a smokeless open coal fire, but that, under efficient conditions of management, there are vast differences in the smokiness of fires—that those which give the greatest amount of heat for the least amount of coal consumed emit the smallest amount of smoke, and that therefore efficient coal fires are to a certain extent smoke abaters.

Dr. Des Vœux further explained that eight years ago he had put in a coke boiler for the hot-water supply of his house, and each year since had been more satisfied with it. He had a gas log-fire in his consulting room; an anthracite closed stove in his dining room; an open coal fire in a Florence grate in his morning room; and gas fires in his bedrooms. The dryness noticeable when gas fires were burned in a room with no ventilation could be entirely removed if the windows were open an inch or two, so that this property was actually an advantage, not a drawback. Dr. Des Vœux also discussed electric heaters, anthracite stoves, coke and other smokeless fuels, oil stoves, and hot-water systems, and stated that "smokeless cooking will rid us of 600,000 dirty chimneys, and the effect will be so enormous that our proselytising will be no longer needed."

In his explanatory remarks the author referred to the two theories of fog—*i.e.*, whether it is due to radiation or smoke. He pointed out, in favour of the last contention, that the fog came an hour later on Sundays than on other days. This, he said, was the case with the fog we had at the beginning of the week. The reason for this was simple. People always got up about an hour later on Sundays, and consequently the smoke from the fires was an hour later. He expressed an opinion that there was a great want of economy in the use of bituminous coal. He did not, he said, agree that legislation would not cure the smoke nuisance. He thought that the law should step in and prevent the nuisance. But he did not explain how this was to be done. Regarding domestic stoves, the author said that gas stoves are only used as a subsidiary means of cooking in most houses, and that very few people used them alone.

The next paper on the list was that by Sir Charles Cookson, K.C.M.G., C.B., on "Coke (Charred Coal) as a Domestic Fuel." In this the author narrated his own experience at his house in Cheyne-walk. Here he has seven grates using coke only. One of these is the Garland grate of the most modern pattern; three of the ordinary eighteenth or nineteenth century make; two are large open grates, and the seventh is in the kitchen. In all these grates no bituminous coal, but only coke, has been used for five years, and in no case is any special apparatus, as far as the grate is concerned, required. The main difficulty was in the lighting of the fuel. This had been overcome by putting under the grate an iron pipe connected with the gas service of the house and perforated by air holes at the side so that the gas when lit reaches the coke laid on the lower bars of the grate. The gas took about ten minutes to ignite the coke, and the average consumption during that period was something less than 6 cub. ft. of gas. After this time the gas was turned off and the fire kept up for the rest of the day by coke alone. Sir Charles adduced figures to show that a saving of some 50 per cent., excluding the cost of lighting materials, as compared with the cost of coal is brought about by this method. He had no hesitation in saying that no unhealthy fumes were given out by the coke fires. In the absence of the author, Dr. Mortimer made some remarks on his behalf. He—Dr. Mortimer—strongly advocated the use of coke for domestic purposes, and explained a method by which he had obtained most excellent results. This was almost exactly similar to that described in Dr. Des Vœux's paper. It only took, he said, about ten to fifteen minutes to get a fire thoroughly alight. Compared with anthracite coal, this method was cheap. It was not unhealthy, there were no dust or smuts. If the fire was very low, it could be rekindled far quicker than an ordinary fire. He thought it was an advantage, however, to use fire-clay bricks, and further said that this class of fire must not be stirred up at the top, and that the ashes should only be removed from the bottom.

The next paper down on the list was by Miss M. Agar, of the Metropolitan Gardens Association, on "The Effect of Smoke on Plant Life." No copy of this paper was, however, supplied to the meeting, nor did the author make any explanatory remarks.

Professor J. B. Cohen's paper on "A Record of the Work of the Leeds Smoke Abatement Society" was then taken. This Society was formed in 1890 with the following objects:—(1) To determine the nature and extent of atmospheric impurities arising from coal smoke; (2) to consider the question of coal consumption in boilers, furnaces, and domestic fireplaces; and (3) to examine the efficiency of the present system for controlling the emission of smoke. Professor Cohen, in supplementing his paper, made some very interesting remarks. He said that the report was not complete yet, but it gave sufficient evidence to show the useful work carried out by the Society. With regard to the soot in Leeds, he had estimated that the 5 per cent. for domestic fireplaces, as given in the report, was very low. He had calculated that no less than 20 tons of soot passed into Leeds daily, and of this large quantity quite half a ton fell to the ground. All that fell was not removed, and it was further estimated that 25 lb. of soot remained. This figure had been arrived at by collecting soot on glass; and was, therefore, extremely likely to be much below the true value. In order to show the effect smoke had on ordinary household materials, he quoted a case in which a person who had moved from Leeds into the country, taking a house of exactly the same size, had greatly reduced the cleaning expenses. He was told that less than half the soap was used, the labour of cleaning was reduced by a quarter, and that white curtains, which formerly only lasted three weeks, now only required cleaning every eighteen weeks. Continuing, he said that one quarter of the daylight is absorbed in indus

trial towns—and by daylight he did not mean sunshine—and that in the winter months this figure was greatly increased. From his remarks regarding the inspector for the prevention of smoke in Leeds, it was evident that he was far from satisfied with the inspector's work. In three years there had only been twenty-one convictions, the fines amounting to £12 9s. 6d. This, he thought, in a place like Leeds, showed that little interest was being taken in the matter. He referred to the good that the Alkali Act had done to minimise the smoke trouble, and thought that the Act could be advantageously extended. Sir William Richmond, on Tuesday evening, had referred to this as being a scientific age; it would have been more correct to say an age of scientific men. The Smoke Abatement Act was certainly not a scientific production, otherwise there would not have been such ambiguity regarding the term "black smoke." In conclusion, he hoped that a resolution would be passed urging the extension of the Alkali Act.

There was also a paper by Dr. S. Rideal, entitled "The Acids of Smoke." This was a paper of considerable interest, which, unfortunately, is too long to publish in full, and of which it would be impossible to give a satisfactory abstract. It should be read in full to be properly appreciated. In his supplementary remarks the author referred to the Smoke Abatement Act, and expressed himself strongly of opinion that the word "black" as applied to smoke ought to be erased. As it stood at present it was almost useless. After briefly referring to the injurious effect of smoke upon buildings, he invited the architects present to give, if possible, information relating to the time of re-pointing mortar in London compared with the same process in other towns. There was little doubt that the figures would be greatly in favour of the country. He also called attention to the fact that the rate of deterioration of iron in towns is much greater than in the country. This, he said, could be obtained by calculating the sulphate of iron in the rust. It would be found that about 10 per cent. of the oxide of iron was converted into sulphate of iron. He estimated that the quantity of sulphur produced from gas in London alone was 1000 lb. a day, and sulphur produced from coal in the same time totalled no less than 100,000 lb. It was popularly thought that gas dirtied silver, but this, he pointed out, could not be the case. It was due to sulphuretted hydrogen, the sulphur coming from the unburned coal, and not from the gas. He objected to the stove described by Sir Charles Cookson on the ground that there was sulphur in the coke which is injurious. He thought that attention should be paid to the elimination of sulphur from coke. Finally, he also expressed a desire to see the Alkali Act extended, and said that he saw no reason why it should not be renamed the Acid Act. The Act had worked well, and it would be wise to extend its influence.

The next paper put forward for consideration was that by Mr. A. S. E. Ackermann on "The Distribution of Producer Gas as a Means of Alleviating the Smoke Nuisance." This paper showed that the percentage of possible duration of sunshine was during the months of November, December, January, and February only half that enjoyed by Southern England, and only some 12 per cent. of that actually possible. During May, June, and July, on the other hand, the percentage rises to 37·8 of the possible amount, the difference being doubtless due to smoke. His proposal was that producer gas should be distributed to houses for warming and cooking, and to factories for industrial purposes. Producer gas has been used in the Gloucester County Asylum for cooking for the last twenty-two years, and at Walthamstow Isolation Hospital for the last five years. The advantages of gas warming and cooking as compared with coal are:—(1) Greater convenience; (2) cleanliness; (3) labour-saving; and (4) economy—especially if producer gas be used. These headings are dealt with in detail in the paper, which also goes into the question of cost.

A further paper by Mr. Arthur J. Martin dealt with the same subject.

The author prefaced his paper with a brief statement of what smoky fogs mean to London. The cost of the artificial light necessitated by fogs is calculated at £7000 per day. Taking into account the disorganisation of business and damage to property, the Hon. Rollo Russell estimates the annual cost of fogs at from £3,000,000 to £5,000,000. During prolonged fogs the death rate, especially from pulmonary diseases, increases to an alarming extent. The situation of London renders it liable to fogs; but the natural fog is white, comparatively translucent, and easily dispelled by sunshine. The worst features of a London fog are due to the soot and acid fumes formed by the combustion of coal. These not only impart to fogs their most malignant characteristics, but prevent their dissipation by the sun. Over 15,000,000 tons of coal are burnt in London every year. During the winter the air required to support combustion amounts in one week to a layer 26ft. deep over the whole area of the metropolis. During fogs the air thus fouled remains near the earth and is breathed over and over again, the amount of carbonic acid which it contains being increased nearly five-fold. At 1s. or 1s. 6d. per 1000ft., it is estimated that gas would compete successfully with coal; and a price of 2s. would greatly stimulate its adoption for heating and power purposes. In Widnes at the present time ordinary coal gas is acually sold at 1s. per 1000, and it has been produced at as low a cost as 1d. In the latter case the gas was a by-product from the manufacture of other commodities in a large chemical works. According to the published accounts of the largest London gas company, the cost of the coal represents nearly two-thirds of that of manufacturing the gas, and of this probably not less than one-half—or, say, 8d. per 1000 cubic feet of gas—is accounted for by the expense of bringing the coal from the collieries. Here, then, is room for a substantial reduction in the cost of gas. The method which the author proposes for bringing this about is by generating the gas at the pit's mouth and conveying it to London in steel pipes at high pressure. He shows that a single line of 6ft pipe will bring from the Yorkshire coalfields a supply of gas equal in heating power to the whole of the coal burnt in the metropolis, thus taking the place of the 550 coal trains and the thousands of horses and carts required for the conveyance and distribution of the coal. The present cost of these services to the consumer is probably something like £9,000,000 per annum. This sum would pay for laying down four lines of pipe, equal in carrying power to the single line of 6ft. pipe, and another £10,000,000 would pay for the engines and machinery required for compressing the gas. Interest, depreciation, and working expenses would amount to £2,370,000, or about one-quarter of what it costs to carry and distribute an equivalent amount of coal.

Mr. Ackermann, in his explanatory remarks, stated that Mr. Martin's paper dealt really with his subject more fully than he had done. They had both been written quite independently, and yet they clearly resembled each other. He gave some interesting data regarding some comparative tests that have just been carried out in America. The comparison is between the amount of coal used to produce one electric horse-power—the machine used being of 200 electric horse-power—in the first instance by steam, and in the second case by suction gas plant. The former method required approximately 4 lb. of coal, and the latter 1·61b. of coal per electric horse-power, the ratio working out at 2·57. He briefly referred to the harm done by manufacturers and agents in making absurd claims for their grates, as, for instance, when they claim that their grates consume their own smoke. He pointed out the fallacy of the statement, but it is unnecessary for us to go into it here. Mr. Martin thought that the keynote of the situation regarding smoke abatement had been struck by the chairman and the previous speaker when they referred to a cheap gaseous fuel. Mr. Ackermann had advocated producer gas. With this Mr. Martin did not agree, but inclined to the use of ordinary gas. For this he gave two reasons. The first is because he does not wish to see any more pulling up of roads in order to lay the necessary new mains, the second reason being that with a producer gas it requires about 4000 cubic feet of gas to do the same amount of work as can be done with 1000 cubic feet of ordinary gas, and this, of course, considerably raises the price of power, probably not above ordinary gas, but still sufficient to cause one to hesitate before advocating large schemes. He then explained how he arrived at the estimate of ¾d. for bringing up to London gas from the pit mouth, instead of paying 8d. per ton of coal, as is done at present. The size of the mains was also dealt with. In conclusion, Mr. Martin proposed that a permanent committee should be appointed to deal with the question of husbanding our coal supply, and those questions relating to the abatement of smoke. Dr. Mortimer, in seconding the resolution, said he was a firm believer in gas for heating and cooking purposes. Some time ago he was not. He did not propose that coal should be abolished altogether, because that would be absurd. Coal can be used without producing smoke under certain conditions, and even domestic grates can give highly satisfactory results. He had recently attended some trials on the grates at the new Government buildings at the corner of Whitehall, and although he was unable to detail the results, he, nevertheless, thought that he was at liberty to say that the trials proved the grates to be highly efficient.

In the general discussion which followed, Mr. H. C. Horsfall said that it was quite possible to reduce smoke very considerably. He remembered meeting some Germans three years ago who had been spending a short time in England in relation to smoke abatement. They were quite surprised to find the awful condition of some of our large towns. They had told him that within ten years the amount of smoke at Hanover had been reduced by two-thirds, and they saw no reason why that should not be the case here. He then described a system that he had been using in his house for twenty years with most excellent results. The fire is burned in an open grate, and the diameter of the flue is only 10in. The secret of his success rested in the use of an Arnutt device designed about fifty years ago. He was sorry that the Smoke Abatement Committee had refused to try this arrangement, as he felt sure the results would have been interesting. Dr. Ormanby regretted that there had not been opportunity to read the papers before attending the meeting, as it greatly handicapped those who wished to take part in the discussion. He considered that it was an impossibility for people to employ gas in the one grate they make use of all day, owing to the need for hot water. One of the speakers had suggested the use of coke stoves fitted with hot water jackets. It was all very well, said Dr. Ormanby, to make these suggestions, but the matter rested with the builders, and they would have to be seen about it, if any further progress was to be made in the matter. With regard to the convictions mentioned by Professor Cohen, he thought that the cure for the smoke nuisance did not depend upon fining manufacturers, but rather on showing them how to economise their fuel consumption. He asked Dr. Rideal if he had taken the samples of rust he had tested from the protected parts of structures, as otherwise he would have expected the sulphur to be washed away. Mr. T. G. Marsh said he was not a believer in legislation by municipal authorities, he believed that conferences, such as was being held, would do far more good than legislation to cure the nuisance. He cited a case in which a firm had been using about 500 horse-power had substituted for producer gas steam, and there was now no smoke at all. This had not been done with any æsthetic motives, but simply because of economy. He considered the Committee would do well to circulate lists giving economy of producer plants over steam engines. Councillor Muirhead, of Liverpool, would like to have heard something about electricity. As regards legislation, he was quite in agreement with the last speaker, and considered that no new laws should be made unless drawn up by experienced men. But he was of opinion that if gas is to be used in all ways, *i.e.*, power and light, then the works must be owned by municipal authorities. Mr. B. H. Thwaite thought that the best suggestion that had been made was the use of by-product coke in conjunction with gas. It only required 10 cubic feet of gas to light the fire, which was hardly worth considering. He agreed with Mr. Ackermann that the candle-power required by law should be reduced to eight or ten candles. This would be advantageous, especially when it was used for heating by gas. Mr. Ernest Dowson agreed with Mr. Martin's statement that coal gas is better than producer gas as far as the power available per 1000 cubic feet of gas is concerned, and also that producer gas carried long distances in pipes is robbed of some of its hydro-carbons. Mr. Thos. Potterton, referring to hot water for small dwellings, stated that he had an apparatus—a slot meter—by which for 27 cubic feet of gas he gets a bath, the water being 95 deg. Fah. This result is obtained assuming the water to be 40 deg. to commence with. After having heated one lot of water it is possible for him to obtain a second bath at a temperature of 105 deg. with a consumption of only 20 cubic feet of gas.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

"COACH" WEIGHTS.

SIR,—The perusal of Mr. Charles Rous-Marten's article—"Newest Caledonian Engines and their Work"—published in the current issue of THE ENGINEER, has proved of great interest to me. I would, however, like to indicate an obviously inaccurate statement on the part of your contributor. The load of the West Coast express is given as 404 tons, and this weight is described as representing forty South of England coaches, which—without considering the various types of vehicles forming the train—is a considerable overestimate, for 10 tons is not the unit determined by the southern lines for the purpose of defining "one" coach. To instance a typical South of England train—the Sunday Pullman Limited, to Brighton, usually comprises one 12-wheeled and six 8-wheeled cars, and these vehicles, together with two 6-wheeled brakes, weigh with passengers and stores 252 tons; the official computation, however, is sixteen and not twenty-five coaches, which, according to your correspondent's comparison, would be the case. Perhaps Mr. Chas. Rous-Marten will enlighten me.

MONTAGUE F. LONG.

West Norwood, S.E., December 12th.

[With pleasure. (1) Officials usually give me the number of "coaches" in a train. Knowing the weight, I divide that by the number, and find the quotient to equal 10 tons—or 10 and a fraction—per "coach." (2) I have often been officially informed that on the railways in question only four-wheelers and six-wheelers are reckoned each as "one coach," eight-wheelers—many of which weigh only 18 to 19 tons—being computed as "equal to two." (3) In Mr. J. P. Pattinson's works on the "Southern Railways," which were compiled under official auspices, it is expressly stated more than once that the train loads are estimated on the basis of 10 tons per coach. (4) The "Sunday Pullman Limited" to Brighton—though a most admirable train in every way—is in no possible respect "a typical South of England train," but wholly the contrary, being absolutely unique on that line, which has no other train resembling it in the remotest degree. My references were to normal train working, not to "Limited Sunday Specials," excellent though these may be.—CHARLES ROUS-MARTEN.]

RECENT DEVELOPMENT OF THE LOCOMOTIVE ENGINE.

SIR,—I read with great interest the article appearing on pages 529 and 530 of your issue of December 1st on "Recent Development of the Locomotive Engine," which article, although containing valuable suggestions for thought, leaves us—as it was perhaps intended to do—just where we were in our knowledge of the compound locomotive and the claims which may legitimately be made both for and against it. I notice, however, your statement that it seems to you to be only a logical conclusion that if the size of locomotive boilers is doubled or trebled, the number of cylinders ought to be increased, and it is obviously your opinion—judging from the general tone of the article—that such cylinders should be operated on the single expansion principle. It must be remembered that by increasing the cylinder capacity, the necessity for employing a greater adhesion weight at once comes to the fore, if the additional piston effort is to be turned to useful account, otherwise the only result of fitting the large cylinders would be to slip the driving wheels every time it was sought to utilise the real power of the engine. It is not always advisable to use six-coupled wheels in a passenger locomotive, nor to restrict too greatly the diameter of the wheels, so that the only course open to designers is to keep the cylinder capacity relatively low in cases where they desire to use only four-coupled wheels. Take the Great Northern Railway, for instance; Mr. Ivatt, in his more recent Atlantic type locomotives, employs very large boilers and relatively small cylinders. In this he is undoubtedly following a wise course, for he is prevented from employing more than an 18½-ton load per axle, and two cylinders of nominally 19in. diameter using boiler steam may be considered as ample in proportion to this. If he built a six wheels coupled engine he could at once increase the cylinder capacity, for then the adhesion load would be augmented and, as a consequence, the extra cylinder power could be taken advantage of. Even in the Doncaster-built compound, No. 902 the four cylinders when working simple are only equal to two of 19½in. by 24in., but there is no doubt that the fact of the work through being distributed over four cranks instead of two, assists in preventing slipping of the wheels. It seems to me that as the power of locomotives is limited to such a great extent by the adhesion weight available, the cylinder capacity must be regulated accordingly. It might be found possible to steam to four 18in. cylinders with the largest boilers in modern practice, but it would be difficult to convert the force exerted by the cylinders into useful work at the rail.

London, W.C., December 12th. CHAS. S. LAKE.

EFFICIENCY OF FLASH BOILERS.

SIR,—In my letter, which appeared in your issue of 8th December, page 574, I am made to say that "it is not practicable to generate and supply saturated steam," &c. It should read: "It is practicable," &c.

It is very important that this correction should be brought to notice. In my opinion, it is due to the fact that most flash boilers are to a great extent, being worked under that unfavourable condition, which accounts for the heavy consumption of oil.

December 11th. JOHN RIEKIE.

GREAT EASTERN RAILWAY.—A reunion of the past and present staff of the locomotive department of the Great Eastern Railway Company was held in the Abercorn Rooms of the Liverpool-street Hotel, London, on Friday, December 8th, when a company numbering forty-nine sat down to dinner under the presidency of Mr. James Holden, M. Inst. C.E., M.I. Mech. E., the locomotive superintendent of the Great Eastern Railway. Among the old Stratfordians present were Messrs. J. H. Adams, W. F. Pettigrew, W. Pickersgill, G. B. Laurence, W. Collingwood, J. W. Howard, Professor W. E. Dalby, Messrs. C. Adams, G. Elliott, T. W. Ford, J. B. Corrie, J. Abbott, J. Cookson, F. W. Dodd, E. F. Elliot, D. Gillies, R. H. Haylock, A. G. Herbert, India; A. C. Kelly, G. Macallan, L. M. Meyrick-Jones, A. P. Parker, Henry Parker, J. Pollock, C. A. Robinson, R. L. Sayer, C. Watchurst, G. Winmill, India, retired; and Signor Solaverani Italy. A thoroughly enjoyable evening was spent, and so great was the opportunity of meeting together appreciated that it was decided to make the reunion an annual event, for which purpose a committee consisting of Messrs. Godfrey Elliott, A. J. Hill, J. W. Howard, W. F. Pettigrew, A. W. Polley, and F. V. Russell, with Mr. James Holden as president, was appointed to carry out the arrangements.

SOME SURVEYING INSTRUMENTS.

By A SWISS ENGINEER.

THE more difficult the ground to be surveyed, the more important it is, of course, to have instruments well suited for the purpose. As the writer found it desirable to try some improvements of the theodolite patterns known to him, he got the renowned mechanician, Mr. Corradi, of Zürich, to make him a special theodolite, which is described below.

The tripod is something like the usual English one.

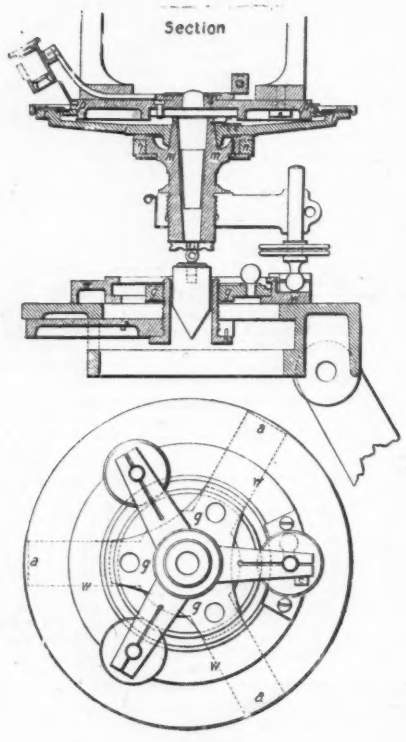


Fig. 1—MOUNTING OF THEODOLITE

To make it easy to carry on the shoulder it is round when folded up, except at the upper ends of the legs, which curve out to be attached to the edge of the tripod head. In the tripod head is a three-armed piece *a*, Figs. 1 and 2, on which is a projecting male screw. This piece *a* has got a side-play of nearly 7 cm. To mount the instrument on the tripod the lower part of the theodolite—the telescope with vertical circle, &c., is, as usual, packed by itself in a box—is placed with the bottom-plate W on the tripod head, and is screwed on to the projecting screw of

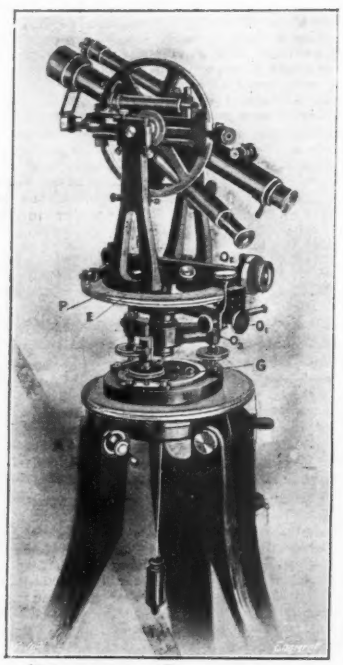


Fig. 2—SURVEYING THEODOLITE

a by means of the female screw-piece G. The instrument is, as a rule, easily centered on the peg—the great side-play aiding this operation considerably—and the screw G tightened on. The telescope is then mounted, and the instrument levelled up by means of the three screws S. The graduated limb *l* is loose on the hollow spindle *m*, only being held on by a small spring *r*, which gives friction enough to prevent the limb from sliding too easily.

The vernier-plate P is fixed on the movable spindle. On the hollow spindle there is a movable collar *n*, on which are the clamping and tangent screws O_1, O_2, and O_3. To set the vernier at zero, the screw O_1 is turned. This tightens the piece *n* on to *m*. Then the graduated plate *l* is roughly shifted to zero by hand, the clamp screw O_2 is screwed up, and final adjustment obtained with the tangent screw O_3. For angle measuring O_1 is loosened, the movable part directing the telescope is turned into the required position, the screw O_1 is again tightened, and adjustment obtained with O_3. The screws O_1 and O_2 are then loosened, the instrument turned to the new direction wanted, the screw O_1 tightened, and adjustment obtained with screw O_3, and the angle read off. The screw O_2 being loosened, the graduated limb *l* rests immovable, as the vernier plate does not touch it, sufficient play between the two being allowed for.

Having the three screws close together is a convenience, and the verniers are set so that they may be read by the operator standing behind the instrument. In many narrow places it is very inconvenient to have to get to the side of the instrument for reading the verniers. The plumb-bob always remains attached to the instrument, the string being fixed in any position by a spring.

Both the horizontal and vertical graduated limbs are 6in. in diameter. The vertical limb is graduated on the edge, to facilitate reading. The standards are made high, and vertical angles up to 680 deg. can be read with it. To assist in the pointing of the telescope, as well as for short sights, too near for using the telescope, the instrument has got a dioptric arrangement attached to it, which comes in very useful. The crosshairs are on a glass plate. The instrument is also supplied with an omnimeter. As the writer, on a mountain survey of difficult character, had had some very good results with an omnimeter-theodolite, he wished to have this apparatus applied on the instrument, though it adds rather heavily to the cost of it.

The omnimeter principle is quite simple, but it demands

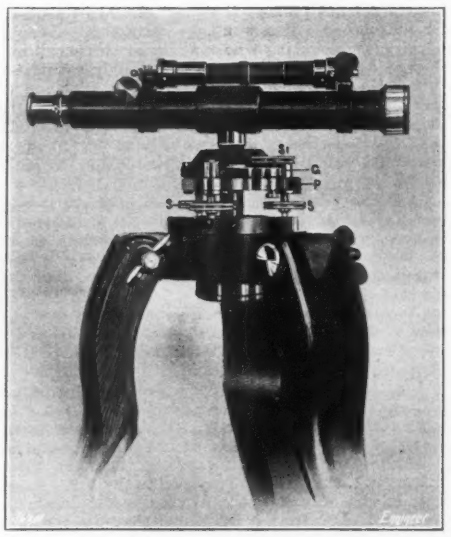


Fig. 3—SURVEYING LEVEL

a rather long rod, and has got the disadvantage—compared with tacheometer methods—that both ends of the fixed distance on the rod have to be very correctly sighted, which, combined with the reading of the omnimeter scale, takes much more time to carry out than the tacheometer reading takes to obtain. The advantage of the omnimeter, however, comes in on long distances, where it permits of greater accuracy than the tacheometer, the range of which, of course, is limited by the accurate readings of the staff division.

For running a traverse on rough ground the omnimeter is especially useful, and for detailed survey the tacheometer cannot compete with the plane table, which has got the great advantage of laying off the horizontal angles directly, and of permitting the contour-lined map to be prepared on the ground itself. An average engineer will soon be able to do much surer and quicker surveying with the plane-table than with the tacheometer, which is very little used here in Switzerland.

The theodolite above described stood its trial well, and did very accurate work too, though it was not meant for any high degree of accuracy. One drawback it has got which also has to be mentioned. According to the wish of the writer, who wanted the instrument as light as possible, the heavier parts of the instrument were made of an aluminium alloy, and, perhaps, because the coefficient of expansion of this metal was too high, or by reason of some other similar cause, the instrument does not, as a rule, keep its sight true for a long time, but alters it rather more quickly than is usually the case. It is somewhat liable to be influenced by vibrations of any kind. These defects are particularly felt on bridge trials. The weight of instrument and tripod = 15·3 kilos., say 33¾ lb.

The level.—The tedious operations with ordinary levels on difficult ground caused the writer to induce Mr. Corradi to make a level as described below.

The telescope is rigidly fixed to the vertical axis and made as light as is practically possible. At the lower end of the vertical axis is a weight, and the whole thing is on a hinged joint, which, when brought into play, balances the telescope roughly in a level position. The hinged joint is in the plate P—Fig. 3—and on this the instrument swings. Another plate, when screwed on to P by the screw S_1, puts the joint out of action. When the screw S_1 is loose the telescope is free to take a position by itself, and when S_1 is tightened it fixes this position, and the final levelling up is done with the three screws S. This arrangement permits of placing the level on the ground without paying any special attention to having the plate nearly level, as it can be set with an inclination of upwards of 25 per cent. without influencing the levelling up of the instrument. On any ordinary steep hillside about one minute suffices to place the level on the ground and to get it ready for sighting.

On the telescope are the usual levels. The long bubble glass has two divisions, and can be turned round its axis so as to use either; the one division is for finer and slower, the other for rough and quick readings.

On the side of the telescope is a small dioptric arrangement for close sights, an adjunct which is of the greatest use on broken ground. The cross hairs are on glass. The tripod is round, if folded up only, the legs being curved out at the upper end to leave the space necessary for the hanging weight.

The weight of the level and tripod = 8·7 kilos, say 19½ lb. nearly. This instrument also proved very useful indeed, and was accurate enough for all railway work.

A characteristic instance of levels taken with this instrument was the following:—In order to check the benchmarks on both sides of the ridge pierced by a tunnel on a Swiss mountain railway, some of them having been damaged by the works, a quick trial was made with the above instrument. The levels were taken up a hillside with a slop of 1 : 1½ for 53 m., then for

Fig. 4—MAYER AND WIESMANN TACHEOMETER

800 m. along a main road, which is tortuous and mostly lined in with pinewoods, after which the levels were taken down a steep hillside with a slope of 1 : 1½ for 50 m. The difference between the two benchmarks was found to be 8 mm. Other known points picked up coming along gave differences of within a few millimetres. The whole operation took three hours' time—between 8.45 and 11.45 a.m.—the weather being favourable. It was levelling up hill 53 m., and down hill 50 m., mostly on very steep slopes, and for 800 m. along a road with 2½ per cent. fall; in twenty-nine placings of the instrument, or on an average ten placings per hour, a 5 m. levelling rod was used, and the staff-holder was a first-rate man.

A tacheometer was invented by Herrn, Mayer, and Wiesmann, engineers on the Simplon Tunnel. Having to deal with the setting out operations in the Simplon Tunnel, the two above gentlemen found it of great advantage to improve the working methods of surveying operations by the introduction of a tacheometer instrument described below. This instrument, though principally well adapted for tunnel work, is, of course, also of great advantage on outside works, and seems to make an eminent practical addition to first-rate modern instruments. The instrument is made almost like an ordinary theodolite, but has three additional pieces, which form its special features. On the side of the standards, and to be connected with the telescope by the tightening of a screw—Fig. 4—and sliding in a slit, is a

vernier, which travels backwards and forwards, following the movements of the telescope, and thus describing the tangent of the vertical angle. Given the distance between the telescope axis and vernier pivot = 1, the scale on the slit is made equal to it, and subdivided into 100 parts; the readings by means of the vernier are thus made to three places of decimals. A similar apparatus is connected to the horizontal plate, and has got a scale and vernier for reading the secants of the

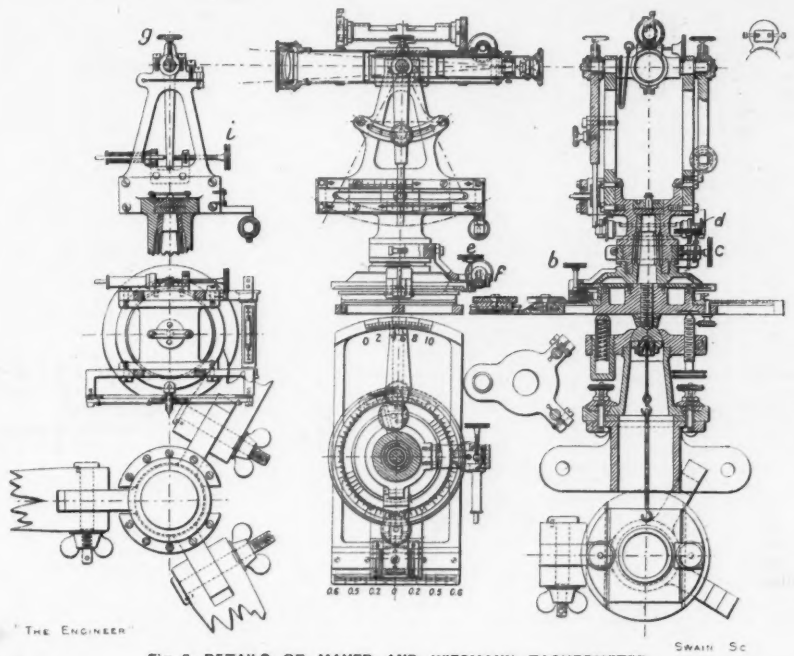


Fig. 5—DETAILS OF MAYER AND WIESMANN TACHEOMETER

horizontal angles, the secants having to be taken into account as soon as exact measurements are required and the angle gets above a certain value. To the horizontal plate is also connected an arc—see Fig. 6—for laying out of curves, which arc is divided so as to avoid the use of tables. If it is desired to use the horizontal tangent or curve apparatus, the screw *a*—Fig. 5—has to be loosened, and the screws *b*, *c* and *d* tightened. By means of the screws *e* and *f* the fine adjustment of the horizontal reading is obtained, the screws *g* and *i* giving fine adjustment for the sighting of vertical angles.

The instrument weighs with tripod 10·6 kilos.—say 23·36 lb.; without tripod, 5·4 kilos.—say 11·9 lb.

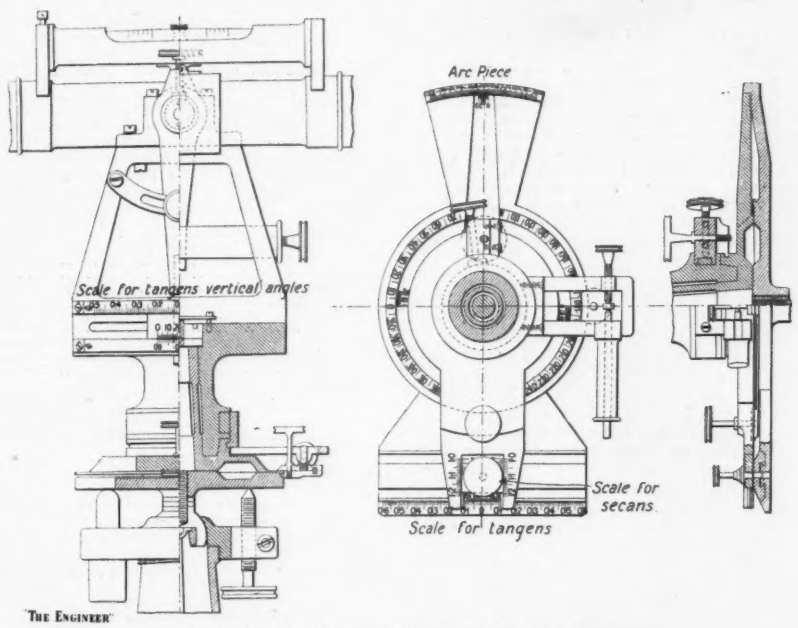


Fig. 6—DETAILS OF MAYER AND WIESMANN TACHEOMETER

GREAT EASTERN RAILWAY MOTOR OMNIBUSES.

THE Great Eastern Railway Company has lately joined the ranks of motor omnibus proprietors, now becoming numerous amongst railways. Its large district undoubtedly affords many promising openings for enterprise of this kind, containing several areas of considerable population and extent quite without means of public transit, other than those afforded by the miserably inefficient means of carriers' carts or vans on market days. The company has done more than most lines to benefit agriculture, but something more is yet wanted to arrest the decline of trade and population which has long been creeping over many parts of the Great Eastern's territory.

By way of attempting to effect an improvement in this respect, the company has lately built at its Stratford works a number of motor omnibuses, from the designs of Mr. James Holden, the locomotive, carriage, and wagon superintendent. The tires and, perhaps, some small special fittings were obtained from outside firms, but otherwise the vehicles were entirely constructed at Stratford. They have four-cylinder engines, working up to 30 horse-power, using petrol in the ordinary way. Both high and low-tension ignition is provided, with Panhard transmission gear. There are four speeds, the highest being 12 miles an hour. All the speeds can be changed by one lever. There are double Sirdar tires on the driving wheels, single on the leaders. Two passengers sit in front beside the driver, sixteen inside, and eighteen outside upon nine garden seats. Curtains, lamps, and large windows, removable in hot weather, make these vehicles quite luxurious. A start was made in August between Lowestoft and Southwold, about 14 miles by road, but 26 by rail. The route lies through Kessingland, Wrentham, and Wangford, and for a good many miles is in view of the sea. An excellent business is done here in summer, when Lowestoft is full of visitors, but the present winter service is of only three trips each way daily, with an extra trip early in the morning on Mondays and Saturdays. The time occupied is 1½ hours, with four stops, and as many others as may be necessary, the fare being 1s. 3d.

Five short trips of 34 minutes are also made to and from Kessingland Beach, a small seaside place not passed by the Southwold omnibuses. An evening trip to Kessingland only, with a late one on Saturday nights, completes the omnibus services working from Lowestoft.

Another omnibus runs from Ipswich by Woolverstone and Chelmondiston to Shotley Pier, a place opposite Harwich, at the junction of the rivers Stour and Orwell. The barely 10 miles is run in one hour, three times each way, with four stops, at a fare of 10d., the neighbourhood being quite destitute of any other public means of access.

South of Norwich lies a large and rather populous district totally devoid of railways. This has been opened up by a service of motor omnibuses, starting from the Victoria Station at Norwich, calling at Trowse Station in the suburbs, and running by Thurton to Loddon, a small town distant about 11 miles. A number of villages lie close to the road, the nearest railway being parallel, but fully three miles off, and practically useless, as the river Yare comes between. The trip is made four times each way in 65 minutes, the fare being 11d. On Mondays and Saturdays extra trips are made, and two of the others altered. A service to Loddon from Beccles Station, in the opposite direction to this, was also started *vid* Raveningham, but after a month's trial had to be withdrawn.

Coming into Essex, an omnibus has been put on between the main line station at Colchester and West Mersea, a village 10 miles to the south, at the mouth of the Blackwater. It is on Mersea Island, but reached through a well-peopled district absolutely isolated from the rest of the world. Three journeys are made each way, occupying one hour, the fare being 10d.

Chelmsford Station is a great centre of motor omnibus traffic, as many as three short services working from there to neighbouring places. One is to Writtle, a large village about three miles in the direction of Ongar. This is reached three times a day in 18 minutes, the fare being 3d. The omnibus goes on to the far end of the village, called Oxney Green, for a penny more. Another is to Danbury, 5½ miles eastwards. This is accessible four times daily, the trip taking 40 minutes, with a stop at Great Baddow. The fare is 6d. Three other journeys are made to Great Baddow only, which is but a couple of miles. A third service from Chelmsford is to Great Waltham, *vid* Broomfield. The 4½ miles is run in 27 minutes, four times per day, with a couple of regular stops. Fivepence is the fare. The Chelmsford services are partly for the purpose of developing residential traffic, parcels and light goods not being conveyed on every trip.

During October an omnibus was run from Clacton Station, calling at the pier, to St. Osyth, a very pretty excursion of about five miles. This was done in 32 minutes, three times each way, for a fare of 6d. In this case, and also in that of the Lowestoft omnibuses, parcels heavier than 14 lb. are not taken, but on all the other routes packages and light goods up to 112 lb. weight are conveyed, the charge being 1s. This is always subject, of course, to there being room for them. Following the Great Western's example, the company has found it necessary to prefix "Condition of roads permitting" to its notices of the various omnibus services. This is especially advisable with the winter coming on, when so many country roads get into bad order. It may be anticipated, we think, that the running of these vehicles will tend towards the maintenance of a good standard of efficiency. Being often the largest ratepayers in a district, a railway company is in a position to bring pressure to bear in the matter, and especially in cases where the comfort of passengers is concerned.

The Lowestoft services being essentially for passengers, neither luggage nor bicycles are carried; but in all the other cases light hand luggage is allowed free, whilst bicycles, if there happens to be room for them, are charged 1s. for any distance. This is also a leaf out of the Paddington book, and amply justified, we think, by the peculiarly awkward nature of those machines when out of their proper sphere. In no case do the omnibuses run on Sundays, but the present arrangements only came into force at the beginning of October last, and are therefore still largely in the experimental stage. They appear to be based on a rate of 10 miles an hour, including stoppages, and the familiar railway rate of one penny per mile, and no doubt will soon cultivate a remunerative traffic.

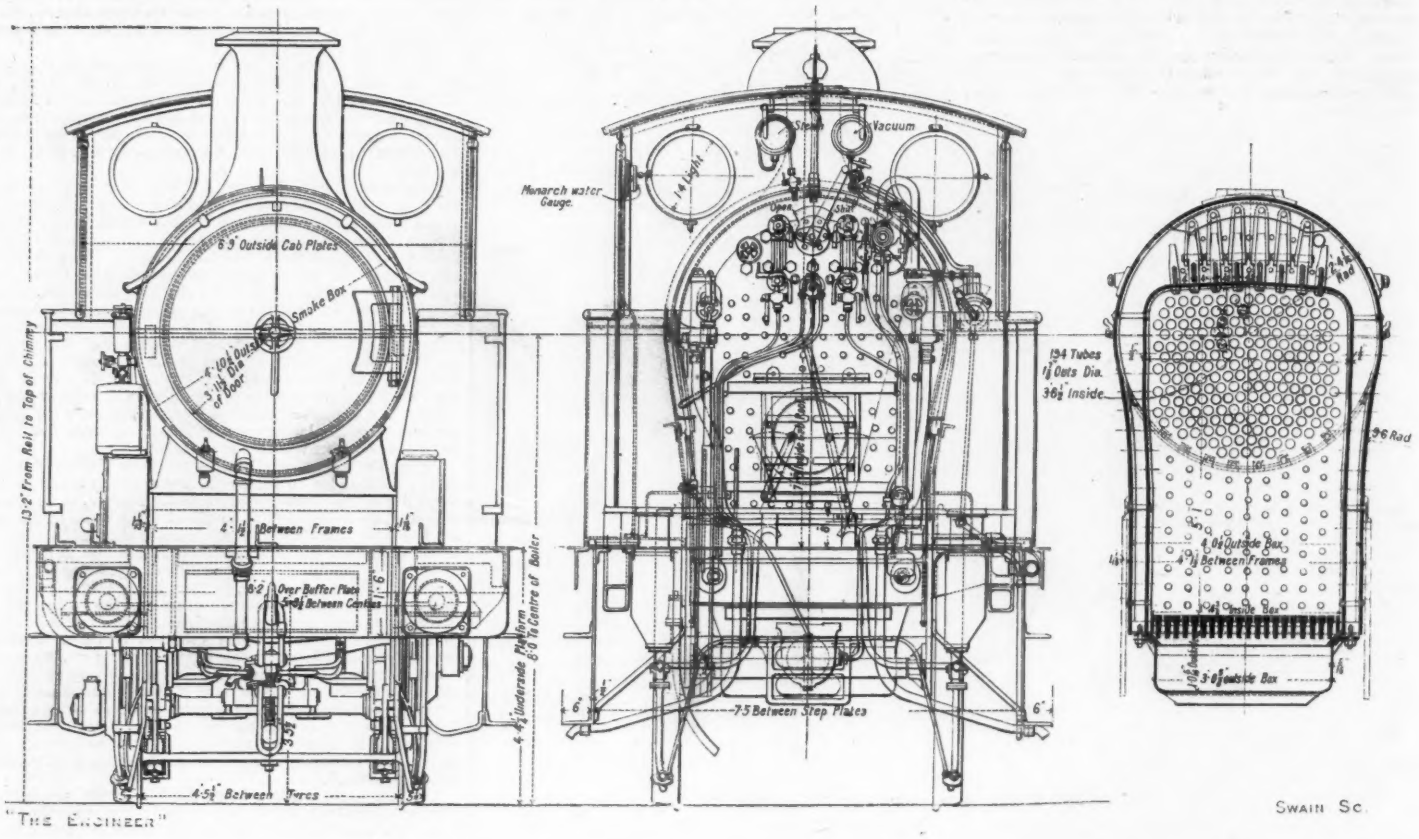
A CENSUS OF AMERICAN LOCOMOTIVES.

IN several respects the Report of the Inter-State Commerce Commission, issued at Washington, is superior, from the point of view of the engineer and statistician, to the annual railway returns issued by the Board of Trade. These general points we do not propose to enumerate on this occasion, but to deal with what they reveal concerning the types of locomotives in use in the United States. The Report for 1903, which has just been received at the one London library where it can be studied, makes use of the same classifications as were employed in the 1902 return, into single expansion, four-cylinder compound and two-cylinder compound locomotives. Sub-divisions according to the number and purpose served by the wheels of the locomotives are provided. These are represented alternately by a letter and a numeral or by an arrowhead, with large circles to represent driving wheels, and smaller circles to represent leading or trailing wheels, a method not comparable in regard to simplicity with that used in England of denoting by numerals only the arrangement of the wheels. Thus a four-coupled bogie express engine would be designated in the Report of the Inter-State Commerce Commission as C2,OO oo>, or in the United Kingdom as 4-4-0. In point of numbers this type is the most numerous among single-expansion engines, there being at the end of June, 1903, 11,583 locomotives, as against 11,194 in June, 1902. Next come the eight coupled engines with single leading wheels—2-8-0—which number 8340, an increase of 2319 within twelve months. Six-coupled engines with single leading wheels have increased from 4639 in 1902 to 4991. Six-coupled engines with leading bogies number 7927 as against 6925 twelve months before. Other types of single-expansion engines could nearly all be matched from current English practice, excepting for engines with ten-coupled driving wheels, or six trailing wheels.

The four-cylinder compound locomotives number in all 1953, as against 1175 in 1902, the majority being "Consolidation" engines—2-8-0—which amounted to 851. Next in point of numbers under this class are six-coupled bogie express engines, which numbered 502. Mention may also be made of the "2-6-2" class, which numbered 168; of the "4-4-2" class, which amounted to 155; and the 150 engines of the "2-6-0" pattern. The only single-driver engines of the familiar pattern associated in this country with the names of Stirling and Dean—those with a leading bogie and a pair of trailing wheels under the fire-box—which are chronicled as in use in the United States are two in number, and are of the four-cylinder compound pattern. Something is manifestly wrong—something more than a cipher too many—in the statement which gives these engines an average grate surface of 760 square feet!

The two-cylinder compound locomotives are actually decreasing in number. Whereas 1113 were in use in 1902, this number had fallen to 849 by 1903. The "2-8-0" class is the most numerous, being 317 in number. The other types running into three figures are the "4-6-0" pattern, numbering 279, and the "2-6-0" pattern, numbering 106. So far as this pattern of locomotive is concerned, size is the factor making for the survival of the fittest, and although a

RADIAL TANK ENGINE—NORTH STAFFORDSHIRE RAILWAY



decrease in numbers has to be chronicled, the average weight has increased.

The following table contrasts the average tractive power, grate surface, heating surface, and weight of locomotives, according to their classification by the number of cylinders, on June 30th in 1902 and 1903 :—

	1902.	1903.
Single-expansion—		
Number	35,228	40,443
Average tractive power, lb.	19,946	21,156
,, grate surface, square feet	25	27
,, heating surface, square feet	1,507	1,590
,, weight, exclusive of tender, tons	55	57
,, weight on drivers, tons	44	46
Four-cylinder compound—		
Number	1,175	1,953
Average tractive power, lb.	29,081	30,551
,, grate surface, square feet	43	50
,, heating surface, square feet	2,556	2,702
,, weight, exclusive of tender, tons	85	99
,, weight on drivers, tons	67	70
Two-cylinder compound—		
Number	1,113	849
Average tractive power, lb.	28,515	31,379
,, grate surface, square feet	33	37
,, heating surface, square feet	2,252	2,551
,, weight, exclusive of tender, tons	75	82
,, weight on drivers, tons	63	68

Taking the average figures for all the single-expansion engines, the tractive power, heating surface, and weight have all slightly increased. In the four-cylinder compound engines, the increase in average tractive power is not so great, but the increase in grate area is suggestive, while the average weight has largely increased. The two-cylinder compounds, which have the greatest average tractive power according to the above classification, have a rather smaller average grate area, together with increased average heating surface and weight.

THE AUTOLOC.

A NEAT mechanical device was exhibited at the recent motor car show by the Finchley Motor and Engineering Company, Limited. This we have since had an opportunity of examining at considerable length. The device would appear to have so many applications that we feel certain that a description of it will be of interest to our readers. The principle of the ordinary freewheel has been applied, and in its simplest form the apparatus is shown by the full lines in Fig. 1. In this A is a circular box, in which a cam B is pivoted at C. Two steel balls D and E are placed in between the outside surface of the cam and the inside surface of the circular box. These balls are kept apart by means of a coiled spring F. It will be observed that by the action of this spring the balls are always kept in contact with the surfaces of the cam and the inside of the box. As a result, no matter how much force is used to move the lever G, which is part of the cam B, to left or right in a horizontal direction, it cannot be made to move. The reason for this will become evident on consideration of the position of the cam, as shown by the dotted lines. Of course, this position is much exaggerated, for in order that it might be possible, it is evident that the cam would have to cut right into the ball E, which is manifestly impossible. As a fact, as soon as ever there is a tendency to move the lever G either to right or left, one or other of the balls is gripped, and no movement is possible. Thus, if A and B are two members of a rotating or sliding mechanism, the application of this device, which its makers call the "Autoloc," renders relative movement between A and B impossible. The greater the force applied, the more efficient the locking.

Unless, however, this locking device could be unlocked at will, it would be of no practical value; the two parts A and B might just as well be keyed together. As a matter of fact, however, it is quite easy to make B more relatively to A, or *vice versâ*. If one of the balls—that on which the grip depends—is slightly pushed at the same time as, and in the same direction in which it is proposed to move B, then no gripping occurs, and B may be put in any desired position. How this is brought about in the simplest form of the apparatus will be quite evident from an examination of Fig. 2. In this a cap has been fitted over the box A. This cap is provided with two lugs H and J, which have the same curvature as the box, and fit into it. The cap can be moved to left or right, round the centre C, in any way most convenient—say, by handle or rod. We do not complicate the drawing with either. As shown in the illustration, the cap is being turned from left to right; that is to say, anti-clockwise. It will be seen that the lug J is impinging against the ball E, and the lug H against the lever G. If, then, the cap is turned, the ball E is just sufficiently pressed to overcome the pressure of the spring F, and to prevent it jamming, and the lever G may be turned to any desired position. As soon as pressure is taken off the ball E, *i.e.*, as soon as the cap ceases to be turned, then the spring F re-asserts itself, and the lever G once more becomes locked, and will remain so until the cap or key is re-applied. It will be understood that with the two lugs H and J the lever may be turned in either direction. For light work, we are informed that two balls have been found to work amply well. For heavier work,

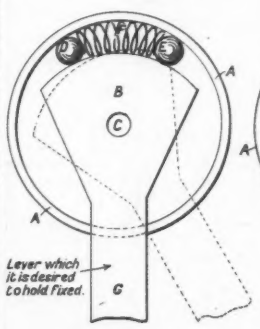


Fig. 1

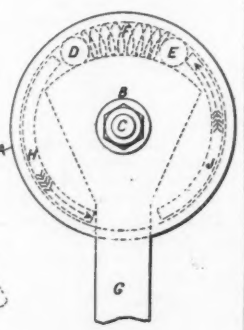


Fig. 2

however, two sets of two balls, each couple held apart by a spring, and placed diametrically opposite to one another, working on two cams, are employed.

It will have been evident by what has gone before that the "Autoloc" must have a number of applications. We understand that though it has only recently been introduced, it is being extensively employed for various motions on motor cars. By its use ratchets, pawls, and springs may be done away with. Moreover, the adjustment may be made much more delicate than is possible with a ratchet with its definite size of teeth. In this respect it has, so we are informed, been found exceedingly useful for tightening telephone and telegraph wires. To enumerate all the various applications claimed for it by its makers would require more space than we can afford. They say that it may be used as a lock, a hinge, or a lever, and that among its principal applications, in addition to those already mentioned, may be quoted steering for boats, elevating and traversing gear for guns, trunnion bearings as applied to searchlights, telescopes, &c.; link motions for steam engines, valves and taps, and friction clutches. There is, in addition, one application to which we are specially asked to draw attention, and that is to the locks of railway carriage doors. The lock as made is fitted with a slam catch, so that the door becomes and remains shut by being slammed to, whilst the turning of a handle—which may be fitted to either or both sides of the door—operates to lock it in triple manner, and so that the lock is proof against vibration or other exterior force.

So far we have only been able to experiment with one of these "Autolocs" unapplied to any special purpose, but from what we have seen we see no reason why the claims of the makers should not be fulfilled. In the two forms in which we have seen it backlash may be said to be absent, and without the cap or key it was impossible to turn the lever relatively to the box.

SIX-COUPLED RADIAL TANK ENGINE.

ON page 594 and above we are enabled, by the courtesy of Mr. John H. Adams, chief locomotive engineer to the North Staffordshire Railway, to give drawings of a new series of six-coupled radial tank engines. These engines were constructed to Mr. Adams' designs by the Vulcan Foundry, Limited, of Newton-le-Willows, and their principal dimensions are as follows :—

Cylinders	18½in. by 26in.
Boiler—	
Diameter of barrel	4ft. 7in.
Length of barrel	11ft. 3in.
Working pressure	175 lb. per sq. in.
Heating surface—	
Fire-box	108·3 sq. ft.
Tubes	1057·3 sq. ft.
Total	1165·6 sq. ft.
Grate area	17·8 sq. ft.
Wheels—	
Coupled	5ft. diameter
Radial	4ft. diameter
Water—	
Capacity of tanks	1700 gallons
Coal—	
Capacity of bunkers	3½ tons

The general arrangement of the locomotive is well shown in the engravings. Mr. Adams informs us that these engines have been working for some time now, and have been doing exceedingly well, hauling heavy trains of goods and minerals over the South Staffordshire system—which abounds in steep gradients—in a very satisfactory and economical manner.

RAILWAY EXHIBITION.—In connection with the United Kingdom Railway Temperance Union, an Industrial and Loan Exhibition—of which H.R.H. Princess Christian, the chairmen and general managers, and other officials of various railways are patrons—will be held in the Corn Exchange, Sheffield, during the first week in May, 1906. Exhibits in the Industrial Sections will be received from railway men of all grades, on any railway. There will also be special classes for railway lads, railway men's wives, and children under fourteen years of age. The Committee will be glad to receive offers of pictures and other objects of interest for the Loan Exhibition. Applications for schedules and other information should be addressed to Mr. A. C. Thompson, 4, the Sanctuary, Westminster, S.W.

ROYAL METEOROLOGICAL SOCIETY.—An ordinary meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, on Wednesday, December 20th, 1905, at 7.30 p.m. Papers to be read :—(1) "Kite Observations from a Trawler in the North Sea," by George C. Simpson, B.Sc., F.R. Met. Soc. (2) "Investigation of the Upper Air in the West Indies by Means of Kites," by C. J. P. Cave, F.R Met. Soc, and W. H. Dines, F.R.S. (3) "Temperature Observations during the Partial Solar Eclipse, August 30th, 1905," by W. H. Dines, F.R.S (4) "Comparison between Glaisher's Factors and Ferrel's Psychrometric Formula," by J. R. Sutton, M.A., F.R. Met. Soc. (5) "A Rapid Method of Finding the Elastic Force of Aqueous Vapour, &c., from Dry and Wet Bulb Thermometer Readings," by John Ball, Ph.D., Assoc. M. Inst. C.E.

RAILWAY MATTERS.

THE Great Northern Railway Company is about to introduce steam rail motor cars on different parts of its system, beginning this week with a supplementary service on the line between Louth and Grimsby.

THE Board of Trade have recently confirmed the Devonport Light Railway Order, 1905, made by the Light Railway Commissioners, authorising the construction of a light railway in the county borough of Devonport.

IT is now certain that the Simplon Railway cannot be ready for opening before May next; but the delay will perhaps permit the adoption of electric working from the commencement, which is greatly favoured by the Italian Government.

THE world's mileage of railway lines is 511,000. The gross revenue per train mile is 6s. 7d.; the average cost of running a train one mile, 4s. 2d.; the average profit per train mile, 2s. 5d.; and the proportion of ordinary expenses to gross revenue, 63 per cent.

A GERMAN student finds one of the causes of the inability of the Russian railroads to handle their traffic is the antiquity of their locomotives. The number of these seems in tolerable proportion to the traffic, but out of 14,326 locomotives no less than 6919 are from twenty-four to forty-six years old.

THE Belgian State Railways earned 227,000,000f. = £9,080,000 last year; and it is thought that this sum will be exceeded by 10,000,000f. = £400,000 during the present year, thanks to the Liège Exhibition and the Brussels *fêtes*. The collective length of Belgian standard-gauge lines, nearly all of which are now State property, was 4571 kiloms. = 2840 miles at the end of last year.

THE Chicago, Milwaukee and St. Paul Company will reach the Pacific Coast by extending the main line west from Evarts. The distance from that point to the Pacific Coast is 1500 miles, and, as it is estimated that the new road can be built and fully equipped for £8000 per mile, £12,000,000 will be needed. In time the line from Chamberlain will be extended north to connect with the Pacific Coast extension.

ADVICES from Mexico state that the Pan-American line now has 125 miles of track completed and in operation. There are 200 miles more in course of construction, which, it is expected, will be completed in a few months. The Pan-American is one of the links in the proposed chain of railroads from the northern part of the United States down through Mexico, Central America, and into and through South America.

THE Croydon Borough Council, at its meeting on Monday, refused the offer of the British Electric Traction Company for the renewal of the lease of the tramways, which the company has been working since the electrification of the system five years ago. The lease of the system expires next year. The offer made by the company, and now rejected, was equivalent to an extra payment of £4000 a year to the Corporation.

THE main direct line of the Canadian Northern Railway, extending north-westerly from Winnipeg, has reached Edmonton, a distance of 830 miles. From Edmonton the Canadian Northern is building several branch lines extending from that centre for about 100 miles each. On two of these branch lines, extending to the westward, track is already being laid, and work will continue throughout the winter.

THE Brooklyn Rapid Transit Company's new Williamsburg Station has been designed to accommodate nine turbo-generator units, three of which are now being installed. One of the most interesting of these is the Allis-Chalmers 9000 horse-power unit. The turbine is of the Parsons type, running at 750 revolutions per minute, and is coupled to an alternator. The turbo-generating unit measures 47ft. in length, 13ft. 3in. in width, and 11ft. 6in. in height above the engine-room floor.

AFTER due notice and full hearing, the Interstate Commerce Commission has ordered that the minimum percentage of air-braked cars in trains used in interstate commerce shall stand increased to 75 per cent. on and after 1st August, 1906. The number of freight cars in the service of the railway companies of the United States, as reported to the Commission on 1st October, 1905, is 1,790,113, of which 1,564,396 are equipped with train brakes. From the best information obtainable, there are also 111,122 private freight cars, approximately all of which are equipped with air brakes.

AMONG the applications to the Light Railway Commissioners of which notice has been given is one seeking for an Order to incorporate a company, and to authorise it to construct a light railway from Middlesbrough to West Hartlepool, with a transporter or conveyor bridge across the river Tees. At Middlesbrough the line will have a junction with the Middlesbrough tramways, and at the Hartlepool end it will also connect with the tramway system there. The line will be of 3ft. 6in. gauge, and will run on public streets and roads, the motive power being electricity. The railway will be close on 7½ miles long, and the bridge about 17 chains. The bridge will cross the Tees at Port Clarence, and will displace a ferry.

THE question of controllers for heavy city cars equipped with four motors is becoming more serious every year, says the *Street Railway Journal*. This is not only on account of the increasing number of such equipments in the United States, but because of the fact that as the car wiring in such equipments gets older and deteriorates, short-circuits in car wiring are more frequent, but because of the inability of the ordinary drum type of controller, under many circumstances, to interrupt short-circuits in car wiring. The trouble is not so much that the controller will not handle the ordinary currents used in car operation, but that any little abnormal current due to defective wiring, or any abnormal arcs due to carelessness or the sluggish throwing off of current will be the immediate cause.

A SOMEWHAT similar accident to that which occurred recently at Charing Cross Station took place during the erection of London-road Station, Manchester, in 1866. According to the *Manchester Guardian*, the old original Manchester and Birmingham terminus was being replaced by a more modern structure. Apparently an insufficient number of pillars had been provided to support the roof, for two of the middle bays of the roof came down, blocking the line, killing two men, and wounding several others. The engineers decided that the new incomplete structure must also come down. Bolts were unscrewed, and two locomotives were attached to heavy chains fastened to the pillars. At a given signal they started, and down came the roof. What is now the old portion of London-road Station was then built.

AN interesting instance of the exaggerated importance which small communities attach to their affairs is afforded by the report of a recent meeting of the Belper Town and Trade Association. This town is at present served by the Midland Railway Company, but the Association would, like many other such places, like to have several lines competing for its favours. Accordingly, at the last meeting, a resolution was passed "that the town and trade ask the following companies, in the order named, viz.:—Great Northern, Great Central, and London and North-Western, if they would receive a deputation respecting the advisability of bringing a new railway into Belper." It would, says the *Railway News*, be instructive to know how much the town and trade will subscribe towards the cost of bringing the new railway to the town.

NOTES AND MEMORANDA.

ENGLISH shipbuilders last month put into the water 32 steamers, of about 92,844 tons gross, against 24 vessels, of 57,546 tons, in October, and 30 vessels, of 70,064 tons, in November last year.

THE best day's run made by the turbine liner Carmania on her first trip to America was 457 knots, and the poorest 305 knots. The exact time of the voyage was 7 days 9 hours 31 minutes. Heavy gales were experienced on three days.

OF the coal raised in the British Isles, 26 per cent. is used in metallurgical operations, 19 per cent. in steam raising generally, while 15 per cent. of it is used for domestic purposes. Eighteen per cent. is exported to foreign countries, Colonies, &c., while 6 per cent. is burned by steamers at sea.

DURING November Scotch shipbuilders launched 26 vessels, of about 57,398 tons gross, as compared with 42 vessels, of 64,211 tons gross, in October; and 24 vessels, of 28,270 tons, in November last year. In the eleven months Scotch builders have launched 305 vessels, of 514,891 tons gross, against 293 vessels, of 388,674 tons, in the corresponding period of last year.

STATISTICS show that since June 1st, 1904, 23 new furnaces, with a capacity of 3,137,000 tons of pig iron a year, have been blown in, and that 16 furnaces, with a capacity of 1,830,000 tons a year, are now under construction in the United States. It may be added that plans for as many as 15 modern blast furnaces, in addition to the 16 now building, are quite sure to be put through.

AN ingot mould casting of unusual dimensions was completed last week by the Brightside Foundry and Engineering Company, Limited, at their Newhall works. The casting was for a gun forging, and was made to the order of Messrs. Cammell, Laird and Co., Limited. The weight of the cast metal moulded and poured into the mould was 84 tons. The casting measured 15ft. by 8ft. 6in.

DURING 1904 the imports of unwrought steel and iron and manufactures thereof into Brazil totalled £1,928,855, as compared with £1,689,641 in 1903. The imports of machinery, appliances, implements, and tools were valued at £1,399 542 in 1904, as against £1,234,831 in the previous year. As regards coal, the total quantity imported in 1904 was valued at £1,270,654, compared with £1,215,352 in 1903.

THE War Department at Washington estimates that a sum of £3,200,000 will be required for continuing the work on the Panama Canal to June 30th, 1907. In spite of the report of the consulting engineers in favour of a sea-level canal, the advocates of a lock canal do not despair of getting their views adopted, as President Roosevelt is known to be anxious for the work to be completed as early as possible.

EDINBURGH University has now an efficient engineering department. New accommodation has been secured, which includes a testing laboratory. The hydraulic laboratory is one of the largest in the United Kingdom. A cast iron tank holds about 10,000 gallons of water, and gives a head of 65ft. above the floor level of the laboratory. In a separate workshop are examples of all the ordinary machine tools used by engineers.

THE work of cutting a canal from Marseilles to the Rhône has just been begun by a body of naval engineers, who are digging a well, 400ft. in depth, at Logis-Neuf, in the Commune of Rove, for the purpose of ascertaining the nature of the ground, near the tunnel of L'Estaque, to the north-west of Marseilles. The French Government has granted the sum of £2000 for this preliminary work, which has been carried to a depth of 100ft. without any trace of water having been met with.

THE world's total supply of platinum in 1904 included 9625 troy ounces from South America, and 192,500 troy ounces from Russia. No production of platinum from Australia was reported. An interesting and new occurrence of platinum in a place in Sumatra has been noted by Professor L. S. Hundeshagen. All the American platinum came from California and Oregon. The imports of platinum into the United States during 1905 showed a decline of more than 8000 ounces, due to European control of the supply, which also, of course, aided the rise in price.

THE Italian iron industry derives the bulk of its ore from Elba; in fact, of 247,278 tons of ore mined in 1900, over 230,000 tons were from that island, the other sources of supply being the deposits at Monte Argentario and in the vicinity of Genoa, Turin, and Belluno. The Elba mines are the property of the State, and are leased to mining companies. In 1886 it was estimated that the supply would become exhausted in about thirty years, but discoveries since made have revealed the presence of more extensive deposits than were then anticipated, though it is believed that they will be worked out by about 1920, given a yearly output of 400,000 tons.

IN a paper recently read by Mr. W. H. Coleman before the Philadelphia Foundrymen's Association, the author states that very few modern foundrymen, even among users of positive blowers, care to utilise high pressures in the cupola for several reasons. (1) They find they can get their required capacities at the lower blast pressures; (2) the cupola lining will last longer under lower pressures; (3) oxidation of the silicon and manganese is greater under the high pressures, and this is only compensated by paying more for high silicon grades; (4) the resultant castings are smoother and easier to machine when made under the lower pressures; (5) there is less liability to slag under the lower pressures; (6) greater strength in castings is obtained in melting by the lower pressures; (7) the horse-power required per ton melted is less at low pressures than at high pressures.

THE current issue of the *Chemical Trade Journal* is largely taken up with various articles bearing upon the subject of smoke abatement. After disposing of the fallacy that town fogs are not the result of the smoke emitted from factory chimneys, this paper states that the smokeless combustion of bituminous coal in domestic grates is not an easy problem. The writer has visited most, if not all, public exhibitions of appliances having this object in view, and has been invited to many private trials of apparatus for the prevention of smoke, but, as the outcome, he has not seen one practicable appliance that will give a smokeless chimney at all times, especially during the period of lighting up, while more often than not he has seen a so-called smokeless grate sending off more smoke than the ordinary open coal fire. His belief is that the remedy is not to be found in attempts at the combustion of smoke, but in the supply and use of a smokeless fuel.

IF we take the average day temperature for November, December, and January as being 50 deg. Fah., a cubic foot of air should hold four grains of moisture when completely saturated, but the average degree of saturation being but 90 per cent., it is clear that the air is only holding within it some 3·6 grains of water vapour. If such air be cooled to 40 deg. Fah., a cubic foot of it will throw out about three-quarters of a grain of moisture, and if the air be cooled to 32 deg. Fah., or freezing point, the moisture thrown out by condensation will be nearly twice as much, or about one grain and a-half. This moisture, condensed or thrown out from the air, is the sub-stratum of our town fogs—the sub-stratum to which our town smoke clings, and we are content to call it fog, when we should know better, and call it smoke, says the *Chemical Trade Journal*. From the figures already given it is easy to see that whenever the saturation of the atmosphere with moisture is greater than 70 per cent. at 50 deg. Fah., we are liable to fog.

MISCELLANEA.

THE report on the concrete aggregates test has been issued by the British Fire Prevention Committee. The Committee attach considerable importance to this test with materials in every day use and not subject to proprietary rights. It is the first of a special series.

ACCORDING to Reuter's Washington correspondent, in view of the strategic importance of Port Pensacola, Florida, the Chief Navy Constructor of the United States recommends the building there of a dry dock of sufficient size to accommodate the largest United States battleships.

DUNDEE has executed many important orders for the Indian jute mills, but one of the largest engines yet made has been finished in the Ward Foundry. It is a Corliss engine of 1600 horse-power of the compound-horizontal side-by-side type, and is destined for the Naihati Jute Mills, Calcutta.

A BOMBAY firm has acquired the right to work a tract of the Southern Mahratta country in which manganese ore is found in, it is believed, paying quantities. The advantage is evidently not so much in the superior quality of the mineral as in the short lead to the shipboard. It will be exported from the port of Marmagoa.

THE New Mills District Council on Tuesday adopted a petition to Parliament, for leave to introduce a Bill to purchase the waterworks from Mr. Francis Sumner for £11,000, to purchase from the Duchy of Lancaster all rights of water at Jow Hole, and to extend the gasworks and waterworks, and to supply gas in bulk to other districts.

THE addition of a gun tempering shop to Messrs. W. Beardmore and Co.'s works, Glasgow, will enable this shipbuilding firm to supply their own guns to men-of-war launched from their yard. This new shop is 133ft. high from the street level, and in length 163ft. by 60ft. broad. There is a large new hydraulic forging press for guns.

A CONFERENCE was held in Newcastle-on-Tyne on Tuesday to consider the wages question in the shipyards on the North-East Coast, there being represented at the conference the North-East Coast Shipbuilding Employers' Association and the Boilermakers' and Iron and Steel Shipbuilders' Society. The latter asked advances in wages of 1s. 6d. per week on time rates, and 5 per cent. on piece rates. Their application was granted, the increases to come into operation in March.

IT has been decided to place the United States battleships Oregon and Massachusetts out of commission for extensive repairs, which will probably cover periods of time from one to three years. The Oregon is not now regarded by naval authorities as a modern battleship, and when she is re-commissioned will be placed in the second line of defence, and probably assigned to the Pacific Station. The Massachusetts will be placed out of commission in a few weeks, and probably at the New York Navy Yard for extensive repairs.

A SINGULAR dispute has taken place between D. Stewart and Co., engineers, Glasgow, and the Heckmondwike Urban District Council in regard to water-tube boilers. The boilers, when erected, conformed to the specifications in every detail; but the complaint was that they would not evaporate as required. A Manchester expert stated that the difficulties experienced were due to want of draught and bad coal, and the absorption of the heat by the brickwork, which, if the brickwork had been hot, would have gone into the boiler.

A HYDRO-ELECTRIC scheme for the Maharajah of Tehri-Garwhal, now being carried out, provides for bringing the water from a perennial stream in a small hill-side channel for 1½ miles, and then leading it down in a pipe, which crosses the Bagirtha River suspended from a twin-rope cable of 400ft. span, into a filter and reservoir, which commands the whole town. By shutting off the water across the river and letting it flow down to a Pelton wheel, it drives a dynamo developing 27 kilowatts, which will light the Maharaja's castle and the little town of Tehri.

THE Crewe Corporation are seeking to purchase the street gas mains, which belong to the London and North-Western Railway Company. The directors of the company, however, have replied that they are prepared to continue supplying gas to the inhabitants of Crewe, and they do not desire to treat with the corporation for the sale of the mains. The town clerk was directed to inform the company that it is the intension of the council at the first available opportunity to apply to Parliament for powers to become the gas authority for Crewe and to purchase the street gas mains.

WHAT is perhaps a record in the building of workshops and laying down machinery for a shipbuilding yard has been performed on the Clyde at Old Kilpatrick. Messrs. Napier and Miller, Limited, are now preparing to remove from their present premises at Yoker. In May the ground at Old Kilpatrick was open field and meadow; to-day it is practically ready for the building of large vessels, and a 7000-ton steamer is being begun. A saving of time has, however, been effected in the getting the electric power for the new yard from the Clyde Valley Company, which only began work a few months ago.

A SYNDICATE has been formed to promote a Bill in Parliament to carry out the electric power scheme which is generally known as the "St. Neot's" power scheme. A joint stock company has been registered, with a capital of £60,000, to provide, in the first instance, the financial necessities of the enterprise during the passage of the Bill through Parliament. It is expected that the direction of the St. Neot's Parliamentary Company, which will be formed after statutory powers are obtained, will largely consist of railway directors, who will thus keep closely in touch with traffic requirements.

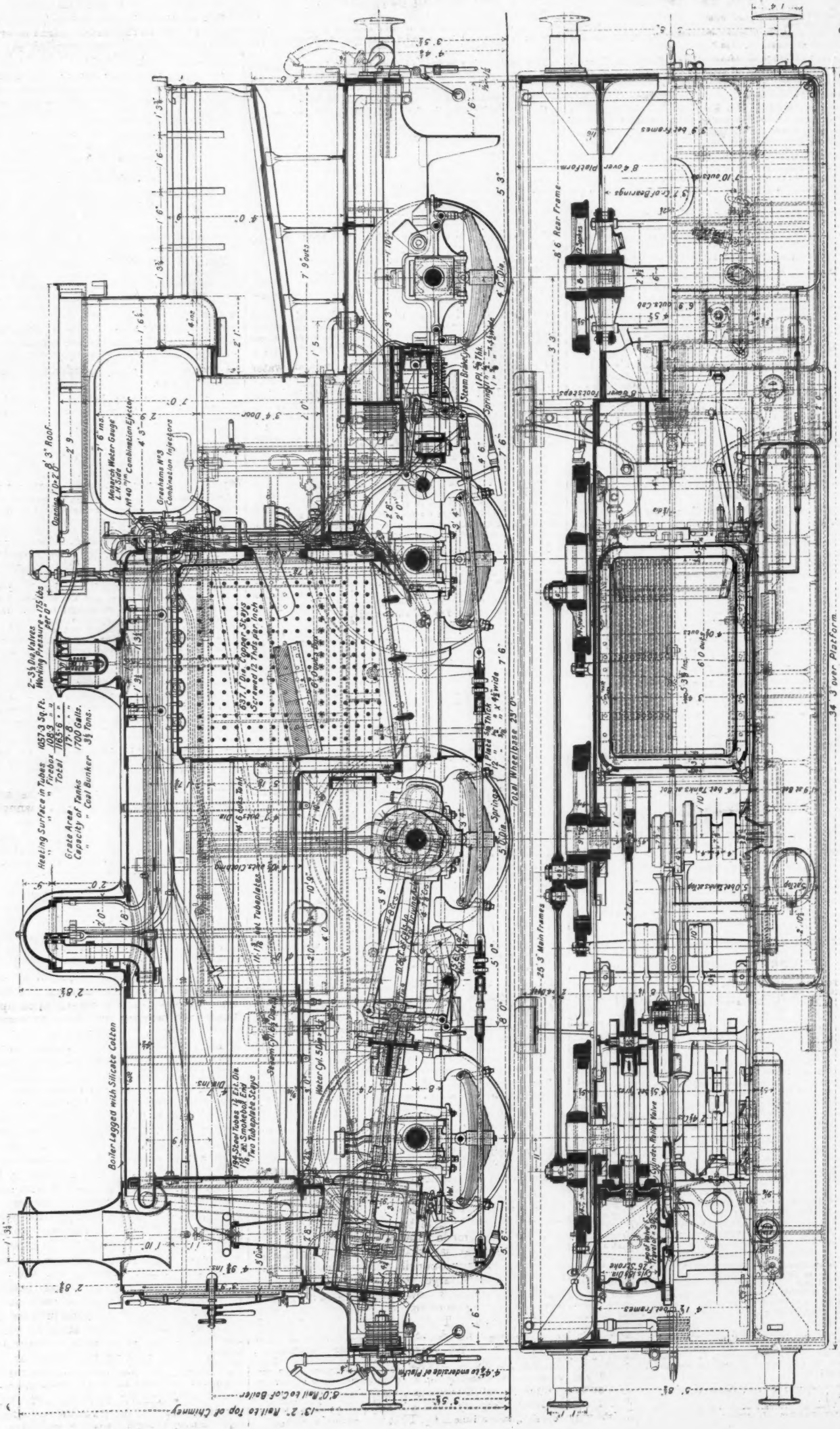
IN a lecture on mining in ancient and modern times, delivered before the Chartered Institute of Secretaries, on December 6th, Mr. Bennett H. Brough explained some of the mining appliances that were now used and that were used in early days and traced the improvements in methods and machines which have rendered it possible to mine with profit copper ore in the Lake Superior district, at a depth of 5000ft.; gold ore at the New Chum Railway Mine, in Victoria, at a depth of 4226ft.; and coal at the Pendleton Mine, near Manchester, at a depth of 3500ft.; to work with profit at Kimberley rock, yielding one-tenth of a carat of diamonds per load, or when only one-hundred-millionth of the stuff coming out of the mines is diamonds; to work with profit at the Atlantic Mine, Lake Superior, rock containing seven-tenths of ore per cent. of copper; and for a gold mine at Bendigo to pay a dividend on a yield of 2 dwt. to the ton of ore.

THE United States Navy Department has received a preliminary report from the Board of Inspection and Survey on the standardisation speed trial given the battleship Virginia on November 23rd. According to this report, the trial was most successful, the propellers of the Virginia having made 0·17 revolutions more than was necessary, according to the calculation, to send the ship along at the contract speed of 19 knots. The authorities at the Navy Department are much elated over the successful outcome of the trial of the Virginia by the standardisation method, says the *Army and Navy Journal*. In the case of the Virginia it was shown that 129·3 revolutions a minute of her propellers meant exactly 19 knots, and as the report received by the Department showed that the propellers exceeded that number by 0·17, it is estimated that the ship exceeded the contract speed requirement by a margin of somewhat less than $\frac{1}{10}$ of a knot

SIX-COUPLED RADIAL TANK ENGINE, NORTH STAFFORDSHIRE RAILWAY

MR. JOHN H. ADAMS, STOKE, ENGINEER

(For description see page 592)


Heating Surface in Tubes 1057.3 Sq.ft.
" " Firebox 108.3 " "
Total 1165.6 " "
Grate Area 17.8 " "
Capacity of Tanks 1700 Gallons.
" Coal Bunker 3½ Tons.
2-35 Dia Valves Working Pressure = 175 lbs per □"
Boiler Lagged with Silicate Cotton
194 Steel Tubes 1⅞" Ext. Dia
18 " Smokebox End
Two Tubeplate Stays
Screwed 12 Threads per Inch
Graham's No 3 Combination Injectors
Monarch Water Gauge & Fittings No 40 ½" Combination Ejector
Steam Brake
Steam Cyl. 5dia
Water Cyl. 5dia
Total Wheelbase 25'0"
25'3" Main Frames
8'6 Rear Frame
13'2" Rail to Top of Chimney
8'0" Rail to C.L. of Boiler
SWAIN Sc

"THE ENGINEER"

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insert on in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

TABITI.—The question you raise is one for a solicitor to answer, and we strongly advise you to obtain proper legal advice.

G. F. (Dundee).—The best method of making all joints of the kind is to leave a narrow band of metal on each part, which should be turned, faced, and scraped to a good fit. These parts can then be bolted together metal to metal, or a very thin asbestos ring, powdered with plumbago, may be put between them.

ELEGY.—See "Engineering Estimates and Cost Accounts," by Francis G. Burton, 2nd edition, Manchester, The Technical Publishing Company, Limited, 1900, price 3s. net. "Workshop Costs for Engineers and Manufacturers," by Sinclair Pearn and Frank Pearn, Manchester, The Technical Publishing Company, price 21s.

EXPECTA.—Any arrangement of parts, old or new, that produces a new result is a good subject for a patent. If your invention involves the use of any new parts or a material alteration in form, no doubt a patent would be granted; if, on the other hand, the invention is only, say, for the arrangement of holes in a butt strap, it is doubtful if a good patent could be secured. We should strongly advise you to consult a competent patent agent about the matter.

J. P. (Fermoy).—The recognised colours are:—Cast iron, grey; wrought iron, Prussian blue; steel, purple (lake and blue); brass, yellow; copper, red-yellow; lead, thin black; brickwork, lake and sienna; concrete, pale wash of sienna or yellow sprinkled with black; green is used for white metal and india-rubber. Where there is any chance of doubt, as in the use of building material, write the name on the section. A band of crimson lake is frequently put round all parts to be machined.

MEETINGS NEXT WEEK.

SOCIETY OF ARTS.—Monday, December 18th, at 8 p.m., at John-street, Adelphi, W.C. Cantor Lectures: "The Measurement of High-frequency Currents and Electric Waves," by J. A. Fleming, D.Sc., F.R.S. (Lecture IV.) Wednesday, December 20th, at 8 p.m. Ordinary meeting. "The Aerograph Method of Distributing Colour," by Charles L. Burdick.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 19th, at 8 p.m. Ordinary meeting. Discussion on paper, "Heat Economy in Factories," by Henry Alexander Mavor, M. Inst. C.E. Wednesday, December 20th, at 2.30 p.m. Students' visit to Inspect the Works in Progress for the Extension to Euston of the City and South London Railway.

THE ENGINEER.

DECEMBER 15, 1905.

THE ELECTRICITY SCHEME OF THE LONDON COUNTY COUNCIL.

IT will be remembered that the Finance Committee of the London County Council reported adversely on the proposals of the Highways Committee for the supply of electrical energy in London and certain surrounding districts. A chief ground of objection was the lack of information on which financial estimates could be based. The Highways and Parliamentary Committees thereupon prepared another report, and this having been considered by the Finance Committee, has evoked an answer. The two new reports are contained in the last issue of the London County Council "Transactions."

Ostensibly we have the details of the new scheme set forth; really there are no details whatever. Sir W. Preece, Mr. Robert Hammond, and Mr. Snell have, we are told, worked hard at the elaboration of a scheme. The result of their deliberations remains, however, a secret in so far as the general public, and to some extent the Finance Committee, are concerned. All that we are told is that a temporary supply of surplus energy is to be had from the Council's generating station at Greenwich; that a new station will be constructed near Grosvenor-road railway bridge, and that another station will be built in Pimlico. It is, of course, impossible to criticise meagre proposals like these. The contemplated outlay is £1,349,000, spread over seven years. The Finance Committee say that they have had certain estimates of working cost, &c., before them, but that they cannot be made public lest the London County Council Bill should be prejudiced in Parliament. It will be remembered that we said in THE ENGINEER for November 17th that electricity could not be generated in London for less than 1·3d. per unit at the terminals of the machines. It is worth notice that none of our readers have attempted to traverse our statement, made after careful inquiry. The Finance Committee say that they anticipate that the London County Council will be able to generate at one or more large stations electricity at a cheaper rate than it is now being produced at the small generating stations of most of the existing undertakings. This is not very encouraging. Although no doubt, economies ought to be secured, it is by no means clear on the one hand, that much could be effected by any one; and, on the other, it is a matter open to question if the Council would or could work as cheaply as a well-managed limited company, with a board of directors striving to pay good dividends. That it is possible to produce electricity at much less than London rates is a matter of common knowledge. Thus, for example, a large generating station might be erected in the middle of a coalfield and supplied, say, with Mond gas. In any case, coal would be obtained at a much less price than it can be had anywhere in London. Ground rent, rates, taxes, labour would all cost less. The only drawback would be the extra cost of transmission, and that, if a high voltage were used, would represent a small sum. Indeed, it is stated, with some authority, that a syndicate is being formed to supply from a vast central station near St. Neots 700 millions of units for the electrification of suburban railways and the supply of existing companies. The proposed capital is £13,000,000. We fail to see in what way any considerable saving can be effected by merely increasing the dimensions of a station, so long as the other charges are all made on the scale peculiar to the metropolis. There is no reason whatever to think that the existing up-to-date stations admit of being improved upon to any considerable extent. We have, of course, heard it said that turbines will work wonders. It may be so; but it is well to keep in mind that they require an enormous quantity of water for condensing purposes, and the cost of water is a very serious item in London. So far the London County Council has not even attempted to make out a good case for its proposals, but worse is to come. The Finance Committee goes to the very heart of things, and is certainly not sparing in its criticisms.

It appears that the London County Council will go into competition with existing companies to a far greater extent than was at first clearly stated. The following quotation from the Finance Committee's report puts the facts before us in the plainest and most unpleasant way:—"We cannot at present say whether the Council could supply at such low prices as would enable it to successfully compete for business with the large power and electric companies who possess powers of supply in bulk throughout a large part of the proposed area. This is, after all, the crucial question, because, as already pointed out, it does not appear that the Council will possess any monopoly, but will be mainly dependent for business, so far as we can see, upon its ability to sell at a price which would induce existing undertakers to take a supply from it. The selling price from time to time will depend upon a variety of considerations which at present are undetermined. A great deal will turn upon the load factor which can be obtained, and the amount of support to be received from authorised undertakers. The price later on may be affected by the progress of knowledge in the methods of generating and transmitting electrical energy, and the action of other companies and bodies which cannot be foreseen."

The proposals of the London County Council made with a great flourish of trumpets, foreshadowed the supply of enormous quantities of electricity at almost nominal prices to develop the industries of the metropolis. It seemed that the absorption or ruin of all other electricity undertakings must be involved. The idea was gigantic—vague, it is true, but for that reason delighted the imagination. The final scheme, if scheme it can be called, is a very different thing. It really amounts, after all, to the outlay of a moderate sum in the construction of a fairly large addition to the existing Greenwich station, and the erection of another station up the river. These two stations will have to compete with existing companies, unless these last consent to become mere distributors of municipal current. The London County Council will possess no special powers of any kind. It cannot be compelled to supply current, nor can it dispossess those who already supply it. Nearly the whole area which is to be supplied is already in the hands of local authorities or companies possessing Provisional Orders. Over a large part of the area bulk powers, practically identical with those proposed to be sought by the Council, have been granted by Parliament to certain power and electric companies. The Council will not, therefore, possess any monopoly in the districts over which bulk powers are possessed by companies, but will have to meet the competition of those companies. In other districts the Council will have no power to secure business except by coming to terms with the existing undertakers. In order to secure business, therefore, the Council must rely entirely on the cheapness of the price at which it can produce electricity, and on this point we have absolute silence. The Finance Committee go so far as to recommend that a definite understanding be arrived at with existing companies, so that some security may be had that loss will not be incurred. This means, of course, that an arrangement shall be made which will stop underselling. That might be very nice for the London County Council, but we hold that it is

to the last degree improbable that the men in possession would regard an intrusion into their domains with pleasure. If the Council is well advised it will abandon the whole scheme. It seems, indeed, impossible to proceed with it in the face of the following statement made by the men who are entrusted with the work of ascertaining what is and what is not justifiable expenditure: "In conclusion, and looking to all the circumstances, we are impressed with the fact that financial risks are inseparable from an enterprise of this kind covering so large an area, and that if such risks mature, the burden will fall entirely on the ratepayers of London." A really good scheme for the supply of electricity in bulk on a great scale and at a low price may yet be worked out. But it requires no very special knowledge or acumen to see that if success is to be attained, the current must be generated in a locality where coal and water are very cheap, and all other charges at least moderate. Nothing very great can possibly be effected in London, when the stations are situated in London. If the London County Council is so far unfortunate that its Bill becomes law, the ratepayers will rue the day. Indeed, whether it does or does not they are likely to lose £50,000 in parliamentary expenses. Their only satisfaction will be that things might have been worse; the loss on the outlay of £355,000 during the year 1907 will be but as a drop in the ocean. Whatever it may be, however, there does not appear to be the least scrap of justification for running the risk of incurring it. London will gain nothing by being supplied with electricity at existing rates. It is by no means clear that the London County Council can sell even at that rate without dipping into the ratepayer's pocket. Considerations of this kind have unfortunately no weight. On Tuesday it was decided by a considerable majority to proceed with the Bill.

THE IRON AND STEEL TRADE.

THE position of the iron and steel trade at the present time is one of increasing prices, growing production, and advancing exports both at home and in the countries represented by our principal rivals. The only question is as to whether the improvement will be of long duration, or, at all events, last for a period which will allow of the British works deriving real commercial and financial advantages from the progress which is now taking place. In former years, when this country occupied the leading place in the iron and steel trade, it was claimed that as soon as the British works were fully employed, the turn of their rivals in the United States and Germany then arrived. Of late years, however, a reversal of this situation of affairs has tended to manifest itself in consequence of the enormous strides made in the production of pig iron and steel both in the United States and Germany. It has even been asserted that, having receded to the third position among the iron and steel producing countries in the world, Great Britain has to accept that portion of the trade which the two nations now occupying the first and second places are unable to deal with on their own account. We are, however, not prepared to agree with this humiliating view of the question, because British iron and steel producers have for a long time past been fully alive to the competitive capabilities of their rivals, and they have in various instances made preparations for more keenly contesting the markets of the world. It is quite true that, with an increasing domestic consumption and the higher prices incidental to protected home markets, the Americans and the Germans do not so largely promote the export trade, but that they exhibit considerable tenacity in regard to the latter is shown by the larger volume of exports in the present year. In fact, so long as the inland markets are in a prosperous condition, so long will the American and German works force the export trade to a less extent, although the increasing production induces them to continue to strive to dispose of the surplus output wherever possible.

It is tolerably certain for the expiring year, at all events, that British iron and steel producers have risen to the necessities of the situation created by the movements of the international markets, and that they intend to make a bold bid for a just proportion of the larger demand existing in the markets of the world. In the first half of 1905 the estimated production of pig iron in Great Britain, according to the statistics prepared by the British Iron Trade Association, amounted to 4,621,000 tons, or about 570,000 tons in excess of the corresponding period of the previous year, and the total for the year is expected to reach nearly 9,000,000 tons. What is, however, of special interest is the fact that in the first eleven months of this year the exports of iron and steel in round figures were 3,434,000 tons, being an increase of 459,000 tons over the corresponding period of 1904. The exports from Germany in the first ten months were 2,660,000 tons, or 355,000 tons more than in the equivalent period of 1904; whilst the exports from the United States in the first eight months only advanced by 106,000 tons. When the figures for Germany are available for the eleven months it will be found that the total is still at least 60,000 tons behind the corresponding statistics in relation to the exports from Great Britain. It will thus be seen that the latter country shows a considerable gain over Germany for this year, and an even greater advantage over the exports from the United States. We do not think that if the home demand in the United States and Germany in the present year had been less favourable it would have reduced our exports, as compensation for a decline in one market would have been obtained by an increase in another, owing to the growing demands of the principal consuming countries.

The most important question for the immediate future hinges upon the problem as to whether the international demands will keep pace with the production. As far as British trade is concerned, the Board of Trade returns reveal a considerable amount of progress, apart from the iron and steel trades, in the engineering, shipbuilding, and machinery branches, and regarded from these points of view the prospects seem to be very encouraging. The chairmen of some of the principal iron and steel companies also look forward with confidence in the future; the shipbuilding industry is actively employed, and in fact everything appears of a rosy character. We should be equally confident were it not for the increasing production of iron and steel in Germany and the United States, to say nothing of the progress made in Great Britain in the course of the current year. It is this advance in the output, combined with the large expansion in the capabilities of production in the United States and Germany, and also in Belgium and France, which causes apprehensions as to the future. Our fears on this point would, however, at once vanish if we were certain that all British iron and steel works had been so far modernised as to be prepared for the great industrial contest which will take place in the next few years.

THE ELECTRIFICATION OF A SUBURBAN LINE.

So many rumours have been current during the last year or two as to the electrification of the London, Brighton, and South Coast Railway that it is a relief to hear that at last a definite scheme has been proposed and sanctioned, and that the contract for the work is, probably, by this time actually sealed. The electrification is, after all, not the serious affair that was talked about. There is no question whatever of displacing steam locomotives for main line work, a conclusion which was foregone some months ago when the company ordered several large express engines; but, on the other hand, a greater length of local line is to undergo transformation than had been reported. The whole circuit from Victoria to London Bridge—the South London Line—crossing the river and descending as far south as Brixton, a line in all some $8\frac{3}{4}$ miles in length, is to be converted to electric traction. The line will therefore constitute the first conversion in the London district south of the Thames, if we omit the extension of the Metropolitan Railway to Wimbledon, that has yet been attempted, and will probably set an example which will in due time be followed by other railway companies.

From other aspects also the change has features of interest. It will be the first railway in this country to be run with overhead conductors, to work on the single-phase system, and to take current at a high voltage. And hereby hangs a tale. It was rumoured last week that the contract for the electrification had been placed with the Allgemeine Elektricitäts Gesellschaft. That is true, but not strictly accurate. The facts are these. The company having decided to transmit current at a high tension, between 3000 and 6000 volts, through overhead conductors, and employ single-phase motors, called for tenders. Few firms in this country were in a position to reply, and of these only one had anything but the slightest experience of single-phase work. On the other hand, the German company had built one railway of the kind the company had set its heart on, and was under contract to build another of larger size. It is hardly conceivable that the company did not know at the time it was calling for tenders that practically only this one firm with actual experience could satisfy its specification. Nevertheless, other companies quoted for what was wanted. Their prices were, we are informed, far higher than the German price, and they were neither able to offer such guarantees as the foreign firm nor to show examples of their systems at work—with one exception, and that case applies, so the company avers, rather to tramways than to railways. The result is that the whole contract has been placed with the Allgemeine Elektricitäts Gesellschaft, but with some important stipulations which materially modify our regrets that it has not been secured by a home contractor. These stipulations are as follows:—To begin with, only a few trains will be ordered, possibly three or four—certainly, we are told, not more than eight; and of these trains the electrical equipment only will come from Germany, all the bodies, frames, &c., being built in this country. Subsequently, as more trains are required, they will be built wholly in this country, the electrical work being probably undertaken at Rugby. Furthermore, the greater part, if not the whole, of the line work will be done by English firms, and it will no doubt account for a very large portion of the bill, since in order to meet any objections that the Board of Trade might raise against the use of a high-tension current in over head conductors, it has been decided to make the post and appliances for carrying the wires of exceptional strength, so that all fears of a breakdown may be allayed.

On the whole, then, there is not much cause for complaint or quarrelling with the arrangement. The profit that is to be made out of the contract—it will probably not be great, if the statement that the German price is very much lower than English prices is correct—will go to Germany, but the greater part of the wages will be paid in England, and several English firms will no doubt glean some small moneys from the execution of parts of the order. That is quite satisfactory. The prosperity of England was built up by holding out inducements to foreigners who were experienced in trades which our people did not understand to settle in this country and teach them. In time we learnt to do better than our masters. We see no reason why a similar policy should not be continued. If Germany has a good single-phase motor let them by all means show us how to make it. To England at the present moment the great point is that employment should remain in this country. Our sympathies are naturally with the contractors who have failed to secure the work, but they will comfort themselves with the reflection that if the German price is much lower than theirs there is not much to be got out of it.

EMPLOYERS AND EDUCATION.

GREAT as are the differences of opinion about a score of things connected with the education of engineers, it is, we think, universally accepted that nothing but good can result from the co-operation of the great employers with our technical institutions. The pure educationalist may educate without any regard to the wishes and wants of the employer, but ultimately his system must fall to the ground if he fails to supply the kind of product that the trade of the country requires. On this point no one is better able to speak than the employer himself, and if we find that he takes an active interest in the technical institutions it is fair to assume that he finds them of some use to him. This we may admit, without shutting our eyes to the fact that there are other influences which may in some cases direct his sympathies. It is instructive, then, to see what amount of interest—practical interest—employers are taking in technical schools all over the country, and this we are given the power to do by the report of an inquiry into the co-operation of employers and technical institutions which has just been issued by the Association of Technical Institutions. This association some time ago circulated fifteen questions to which it invited technical colleges and employers to reply; seventy-five of the forms of inquiry were filled up and returned. Notes of the replies and a general analysis appear in the report before us. In forty institutions there exists some form of co-operation with employers, whilst the other employers render no active help to technical instruction or are absolute opposed to it. For example, in fourteen of the districts with which the report deals, the employers prefer boys straight from the elementary school; in no less than ten of these districts the technical institutions give instructions in engineering. We will not name the colleges returning these unfavourable reports, but we may remark that several of them are well known and distinguished. This attitude of the masters is partly due to a total lack of appreciation of the value of education, and partly, as the report candidly admits, to the fact that "the classes are not sufficiently useful or practical, that the students attending them are a little too ready to regard their class instruction as an 'end' rather than as a 'means,' and not sufficiently to realise the fact that manufactories and works are commercial concerns in which 'time is money' and where habits of discipline, punctuality, and hard

work, are of first importance." Nothing can be added to that brief indictment except to add that the fault must lie primarily with the teaching staff. We heartily rejoice that the Association has recognised this truth, and the fact that it has openly acknowledged it is the best tidings for the future of technical education which we have heard for many a day. We can assure the Association that if it will make its institutions really valuable and useful to the employers, not multiply classes and numbers, but improve the material it has to its hands, it will have the cordial help and sympathy of those to whom technical schools must look for the fruition of their work—the employment of their graduates in responsible positions.

SUCTION GAS PRODUCERS.

MANY of our readers will learn with pleasure that the Royal Agricultural Society has decided to hold a series of trials of suction gas producers and engines at the Derby show next year. Particulars have not yet been published, but we understand that only one size of engine will be admitted; the power will be between 15 and 20 H.P., and competitors will be required to keep their engines in operation continuously during each test, with a variation not exceeding 5 per cent. of their declared power. Each actual run will last nine hours, but in order to approach as closely as possible the condition of actual use, the plant each morning will have to be started up from the state in which it was left overnight. The trials will be held under the direction of Mr. F. S. Courtney, an engineer with a very wide experience of competitive tests, and the actual details—which we hope to have before us in a few days—have been decided upon only after mature consideration and consultation with experts and makers. There is no doubt that no more valuable series of trials could have been chosen, and they will certainly prove a very important feature of the Derby show. We had hoped that it might be possible to carry out a suggestion as to the nature of these trials made in these pages some time ago. It was to the effect that the old plan of testing steam engines by giving a fixed amount of fuel to all competitors and awarding the prize to him whose engine ran longest on it at its stated horse-power, should be followed with suction producers. Unfortunately, limitations of time and other considerations have made the adoption of this plan impossible. Coal will be supplied to the requirements of the competitors; it will be weighed before it enters the producers, and the ashes and coal remaining at the end of a run will also be weighed. We understand that a departure from the course usually pursued at trials of this kind is to be made. The engines are not to be run in sheds, as has been the general rule, but are to be collected into a suitable pavilion, where the competitors will be given the opportunity of making attractive displays of their plants. To this pavilion the public will, of course, be admitted on show days, but the trials will probably take place privately a few days before the opening of the exhibition.

LITERATURE.

High-tension Power Transmission. A series of papers and discussions presented at the meetings of the American Institute of Electrical Engineers. New York: The McGraw Publishing Company. 1905.

THE papers and discussions which form the contents of this book have already been published in the "Transactions" of the American Institute of Electrical Engineers during the past two years. All the papers deal with matters relating to high-pressure electrical power transmission, and the meetings at which they were presented were held directly under the auspices of the Committee on High-tension Transmission. In publishing these discussions in book form, a large amount of valuable information is presented within a small compass convenient for reference, and the book, in consequence, form a very useful addition to electrical engineering literature. Naturally a number of the papers deal with matters affecting overhead lines, particularly with the insulation, which appears to constitute at present the limit to pressure. The first contribution deals with the standardisation of insulator pins. In America the introduction of iron or steel pins for insulators is only of recent date, and the paper is really a mathematical consideration of the fibre stresses in wooden pins, with recommendations as regards standard dimensions and methods of construction. The dimensions proposed for various lengths of pins are given, from those standing 5in. to those standing 19in. above the cross arms. The hole in the cross arm for the former is proposed to be 1½in. diameter, and for the latter 2¼in. diameter. At the thickest part the smallest pin is 1⅞in. diameter and the largest 2⅝in., but all have their tops 1in. diameter, and are screwed down 2¼in. for the insulator. A diameter of 1in. for the top of the pin is decidedly too small for heavy line work, a fact brought out in the discussion, and confirmed by the present American practice, which makes the screwed top of the pin 1⅜in. diameter. The burning of insulator pins, which has occasioned a considerable amount of trouble in America, comes in for consideration in another paper. Illustrations of a large number of burnt pins are given, but in many instances it is not easy to account for the facts observed. The cure for all the evils of pin burning is, of course, to do away with wooden pins altogether, and to use pins of iron or steel.

Next, the insulators claim attention, and the testing of these is dealt with in a further paper. It is pointed out that the shape of the potential wave has a pronounced effect in breaking down the insulation. The wave can be either flat topped or peaked, so that the maximum instantaneous potential is much less or greater than that of a sine wave of the same square root of the mean square potential. The potential, as read by a voltmeter, is little guide to the maximum strain on the insulation, as for the same indication on that instrument the maximum potentials for different machines may differ as much as 2 to 1. Moisture in the atmosphere affects the arcing distance; in steam a given potential will jump twice as far, and in a fog 25 per cent. further than under ordinary conditions. Also at a high altitude where the air is more rarified the arc will jump to a greater distance. In this paper the usual method of testing high-tension insulators is described, and it is suggested that a fair puncture test for an insulator is twice the potential for which it is to be employed, applied between the head and the interior, for one minute. The insulators, for example, for a 50,000-volt line should stand 100,000 volts. As on a 50,000-volt line the potential of any conductor to ground would be about 29,000 volts, the above test gives a factor of safety of nearly 3½ to 1. The necessity for the testing of insulators of a new form under conditions as closely approaching those under which the insulators will work when the line is erected is emphasised. It is said that the conditions of rain and wind can be very well imitated by a sprinkler nozzle played on the insulators at a pressure of 50 lb. to the square inch, and at an angle of 30 deg. to the horizontal.

As bearing on the same subject, another paper and discussion follow on the "Methods of bringing High-tension Conductors into Buildings," and several illustrations of different methods are given. "The Operation and Maintenance of High-tension Underground Systems," and "The Protection of Cables from Arcs due to the Failure of Adjacent Cables" are other matters dealt with, and as regards cables it is noted that most trouble has arisen from defective joints, moisture in the cables near the joints, or sharp bends in the cables.

Amongst many other things discussed is "The Protection of High-pressure Transmission Lines from Static Discharges," which, in other words, means lightning. The opener of the discussion was of opinion that the transmission line could be protected from lightning discharges by suitable apparatus placed in the station, and that it was not necessary to use grounded wires above the line, though he would make exception on any line where poles were shattered with great frequency. But there is no doubt that grounded wires do save the poles, acting as a shield and preventing the potential of the line wires from rising to anything like what would be reached if the grounded wires were absent. Needless to say, with steel construction the poles do not get shattered, but the proper protection of the lines and machinery from lightning is one of the most interesting subjects in the domain of power transmission, the discussion in the volume showing that there is by no means uniformity of opinion on the subject.

There is an opening paper and discussion on the "Y or Delta Connection of Transformers," from which it appears that opinions are about equally divided, some engineers prefering one connection and some the other, with perhaps a tendency on the whole in favour of the Y connection with grounded neutrals. We are glad to see that the use of ground shields in transformers was condemned by practically all the engineers taking part in the discussion on this subject. The design of switching gear and automatic cut out gear are also included in this work, as well as the effect of synchronous motors in phase rectifying on long lines. The book also contains the "Report of a Committee on High-tension Transmission," which gives a very great deal of important information collected from all the engineers in charge of power plants in the States. Confirming what was said at the beginning of this review, the book is a valuable work of reference on power transmission work.

Handbook of Metallurgy. By Dr. C. SCHNABEL. Translated by HENRY LOUIS, M.A. Vol. I. Second Edition. Medium 8vo, 1123 pages. London: Macmillan and Co. 1905. Price 25s.

THE progress of metal smelting during the seven years that have elapsed since Professor Louis first introduced Dr. Schnabel's work to the English reader is brought very prominently before us by the increase in bulk of the new issue of the first volume, which, while containing the same range of subjects—copper, lead, silver, and gold—has been enlarged one-fourth, from 876 to 1090 pages, apart from a detailed index of 33 pages, which was not contained in the earlier issue. The additions, which are to be found in all the four sections, include notices of the American methods of pyritic smelting as applied to low-produce copper ores, the newer developments of copper concentration by the Bessemer converter, including the David "Selecteur." The refining of argentiferous copper and the parting of gold and silver by electrolytic methods are very fully treated, the author having largely utilised Dr. Borcher's work in this direction. Considerable additions have also been made to the article on the cyanide treatment of gold ores, although it can scarcely be said to be brought up to date, having regard to the numerous special works and descriptions at present available in this country. This, however, is due to the circumstance that the German original was completed in the early part of 1901, and much of the current literature is of newer date. For example, we have been unable to verify most of the references given to Dr. Rose's metallurgy of gold, as they are taken from a former edition whose date is not given. A very large amount of the work is taken up by descriptions of obsolete processes, which, however, the author considers will be of value in stimulating the inventive spirit of the metal smelter. This, of course, is a very natural error from the professorial position, but the practical man in a hurry may regard it differently. The author must be under heavy obligations to Prof. Louis for the minute faithfulness of his translation, in which, according to the preface, literary style has been throughout subordinated to literal accuracy. We are inclined to think, however, that a free editorial revision would have given us a more generally acceptable book.

The Design and Construction of Metallic Bridges. By WILLIAM H. BURR, C.E., M.A.S.C.E., Professor of Civil Engineering in Columbia University, in the City of New York, and MYRON S. FALK, Ph.D., J.M.A.S.C.E., Lecturer in Civil Engineering in Columbia University in the City of New York. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1905.

OMITTING the opening chapter of this book, which is purely historical, in the next the general types of trusses, loads, and specifications claim our attention. It is correctly observed that the attempts made to express accurately by means of an equation the dead weight of trusses have not been attended with satisfactory results. There are three principal methods employed for calculating the actual stresses to which a railway bridge may be subjected in carrying traffic. They are known as the method of locomotive concentrations, that of equivalent uniform loads, and the third consists in a partial union of the two. It includes the use of a uniformly distributed load, with the addition of one or two concentrated loads, so placed as to induce the maximum stresses. The authors observe that under the modern methods of bridge computation no appreciable gain is found in the third method, except in special cases. Also that, owing to the standardisation of locomotive loadings, there is but little advantage in using an equivalent uniform load instead of concentrations, and that graphic methods diminish the value of the equivalent uniform live load system. It may be stated *per contra* that "concentrations" frequently cause greater stresses than can possibly come on bridges, and that "equivalents" are much used by European engineers and bridge designers.

There are two methods of treatment mentioned in dealing with impact stresses. One is based on the assumption that the dead load stresses have a value of one-half that of those due to the live load. The other employs formula, in which the stress of impact takes the form of an addition to a prearranged computation. We have still much to learn concerning the dynamic effects of moving trains, and until our practical knowledge and experience is more advanced we cannot expect an accurate solution of the problem. As a study, the analytical investigation of the economic depth of a plate girder is interesting, although there may be two opinions respecting its utility. It is correctly remarked that local circumstances frequently compel a different depth from that given by the equation, and that unless the increase be considerable it is not attended with commensurate advantages, although it does to some extent lighten the stresses on the flanges. Owing to the narrow limits within which its span is restricted, the plate girder offers little or no scope for improvement, and in that respect is a type of bridge which has reached its finality. Its design has become a matter of engineering routine.

In Chapters IV. and V. the subject of trusses with parallel and non-parallel chords is treated of, and the different methods usually employed in the determination of the stresses discussed. No hard-and-fast rule can be laid down assigning special superiority or excellence to any one of them. Each has its own class of examples, with conditions attached to them, for which it is peculiarly well adapted. The form given for the Schwedler girder in Chapter V. is not that of the original design, which was very unsightly. So much so was this the case, that Schwedler himself was among the first to recognise it, and, in 1868, proposed the adoption of a more graceful curve for the top flange, instead of forming it strictly according to theory. The peculiar and unpleasing feature in the original design was that the members of the upper flanges of the panels on each side of the centre inclined downwards, so that they formed a re-entering angle, and caused the central vertical to be a good deal shorter than those on either side of it. Experience has shown that the Schwedler bridge, which is but a modification of the bowstring type, possesses no advantages superior to those belonging to the latter class.

A considerable portion of the volume—some 127 pages—is devoted to the subject of swing bridges. Towards the end the equations become rather complicated and laborious, and not conducive to either practical or accurate results. It is here where the *métier* of the professor and the lecturer comes to the front. The authors deserve all credit for the candid opinion they express. It is remarked with respect to these equations:—"If these formulæ be applied to an actual swing bridge design, it will almost certainly be found that erratic values for the reactions will result. As the results of the applications of the formulæ are highly sensitive to variations in their assumed sectional areas, this process of successive revisions and applications of formulæ will be found laborious and, on the whole, unsatisfactory."

The method of influence lines and of deflections are used in the treatment of swing bridges, as well as the more common procedure with the theorem of three moments.* In addition, the general application of the

* "Graphical Method by Influence Lines," THE ENGINEER, 16th June 1905.

principle of least work to the determination of the stresses in trusses is investigated.

We strongly suspect that neither the English nor continental engineers will accept the statement made in the preface that the present work constitutes a "complete and comprehensive practical treatment of metallic bridges, with the exception of suspension bridges and arched ribs." Many details and data of sound practical value to those engaged in the design of bridges and similar structures, will be found in the extracts from American railway and bridge companies. With the exception of a brief mention, and very few examples, the graphical method is purposely not used in the present volume. The methods employed are analytic throughout, and embrace the most advanced methods of stress computations, without neglecting or ignoring those that are older. Viewed as a theoretical and mathematical treatise rather than as a work for practical engineers it has considerable merit, and is the result of considerable labour and thought, with some originality. It is well adapted, also, for a text-book in general, particularly for the engineering pupils of Columbia University, for whom it may have been intended, and who are accustomed to the American unit system of calculation.

SHORT NOTICES.

British Engineering Coded Lists. Volume II. Issued by authority of the Engineering Standards Committee. London: Robert Atkinson, Limited, 10, Essex-street, Strand, W.C. Price 25s. net. — This is the second volume of the "British Engineering Standard Coded Lists." Our readers will remember from the notice of the first volume of this work which appeared in these columns that the book is issued by the authority of the Engineering Standards Committee. The book deals with the results arrived at by the Committee, and a short history of that body is included in the work. The engineering standards codes are the main feature of the book, but much other useful information is included. Numerous reports issued by the Committee are embodied, and at the end of each report a telegraphic code is given. This arrangement is extremely convenient, as it enables the required phrase or word to be found almost at once, and with a minimum amount of trouble. The reports published in this volume include British standard railway rails; British standard tensile pieces; British standard screw threads; British standard pipe threads; and the British standard specification for Portland cement.

The "Mechanical World" Pocket-book and Year-book for 1906. Manchester: Emmott and Co., Limited, *Mechanical World* Offices. Price 6d.—We have just received a copy of the nineteenth annual issue of "The *Mechanical World* Pocket Diary." Much new information has been added, which greatly increases the value of the diary as a work of reference. For instance, a concise article on "The Steam Turbine," by Mr. R. M. Nielson, has been added. Refrigerating machinery, ice manufacture, and cold storage are also dealt with in this issue. The other new sections deal with speeds and feeds suitable for high-speed steel tools, a table of cutting speeds, and a much-enlarged table of factors of evaporation is given. Numerous additions have been made to other sections, thereby bringing the book up to date and greatly enhancing its value.

The Practical Engineer Electrical Pocket-book for 1906. London: The Technical Publishing Company, 359, Strand, W.C. Price 1s. net.—The electrical edition of "The Practical Engineer" has been enlarged and revised for the 1906 issue. The additions include the recommendations of the Engineering Standards Committee on sizes of conductors for supply mains, copper conductors, &c.; formula for calculating the loss of energy in conductors; localising faults in mains, new testing and indicating instruments; synchronisers; multiphase distribution; revised notes on patents, and much more information that is of interest to the electrician. The book is well illustrated throughout.

The Practical Engineer's Pocket-book for 1906. The Technical Publishing Company. London: 359, Strand, W.C. Price 1s. net.—"The Practical Engineer's Pocket-book," now in its eighteenth year of publication, has been considerably enlarged. Amongst the new additions may be mentioned an account of results of recent tests of mechanical stokers and forced-draught systems; types of indicators; flow of air, steam, gas, and water through pipes; emery wheels; and suction gas producers. Many other alterations and additions have been made which tend to extend the usefulness of this work.

Railroadiana. Birmingham: Edward Baker, 14 and 16, John Bright-street, Birmingham.—We have received a catalogue called "Railroadiana," which gives the names of books, pamphlets, maps, guides, time-tables, &c., connected with the origin, rise, and development of railways, which are for sale. The catalogue contains eighty-two pages, and amongst the contents may be found many books, which, if they are of no practical value to present-day engineers, are nevertheless interesting relics of the past history of the locomotive.

BOOKS RECEIVED.

Practical Pattern Making. By Paul N. Hasluck. London: Cassell and Co., Limited. Price 2s.

The Gold Mines of the World. By J. H. Curle. London: George Routledge and Sons. Price 12s. 6d. net.

Die Dampfturbine. By Wilh. H. Eyermann. München and Berlin: Druck and Verlag von R. Oldenburg. Price M. 9.

Alternating Currents. By Alfred Hay, D. Sc., M.I.E.E. London: Harper Brothers, 45, Albemarle-street, W. Price 6s.

Machine Shop Companion. Third edition. By Wallace Bentley, M.I. Mech. E. London: Chapman and Hall, Limited. Price 1s. net.

The London University Guide, 1906. London University College. University Tutorial Press, Limited, 157, Drury-lane, W.C.

The Autobiography of Samuel Smiles, LL.D. Edited by Thos. Mackay. London: John Murray, Albemarle-street, W. Price 15s. net.

Gasworks Directory and Statistics, 1905-06. London: Hazell, Watson and Viney, Limited, 52, Long-acre, W.C. Price 10s. 6d. net.

Smoke Abatement. By William Nicholson. London: Charles Griffin and Co., Limited, Exeter-street, Strand, W.C. Price 6s. net.

Warmwasserbereitungs-Anlagen und Badeeinrichtungen. By Holgar Roose. München and Berlin: Druck and Verlag von Oldenburg. Price M. 7.

Baku: An Eventful History. By J. D. Henry. London: Archibald Constable and Co., Limited, 16, James-street, Haymarket. Price 12s. 6d.

Des Ingenieurs Taschenbuch herausgegeben vom Akademischen Verein "Hütte." Parts 1 and 2. Berlin: Verlag Von Wilhelm Ernst and Sohn. Price M. 18.

Fire Tests with Floors. By Messrs. R. Faber, Berlin. Published at the office of the British Fire Prevention Committee, 1, Waterloo-place, Pall Mall. Price 2s. 6d.

Brother East and Brother West: A Searchlight on the Unemployed. By Leighton Leigh. London: William Heinemann, 21, Bedford-street, W.C. Price 3s. 6d.

Machine Tools: Their Design and Construction. By Thomas R. Shaw, A.M.I. Mech. E. Manchester: The Scientific Publishing Company. Price 15s. net.

The Alternating Current Circuit and Motor. By W. Perren Maycock, M.I.E.E. London: Whittaker and Co., 2, White Hart-street, Paternoster-square. Price 4s. 6d.

The Design and Construction of Metallic Bridges. By William H. Burr and Myron S. Falk, Ph. D. London: Chapman and Hall, Limited. Price 21s. net.

The Elements of Electrical Engineering. By Tyson Sewell, A.I.E.E. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. Price 7s. 6d. net.

Sewerage and Sewage Purification. By M. N. Baker, Ph. B. New York: D. Van Nostrand Company, 23, Murray and 27, Warren-streets. Price 50 cents. Second edition.

Elementary Electrical Calculations. By W. H. N. James, A.R.C.Sc. (Lond.), A.I.E.E., and D. L. Sands. London: Longmans, Green and Co., 39, Paternoster-row. Price 3s. 6d. net.

Motor Vehicles for Business Purposes. By A. J. Wallis-Taylor, A.M.I. Mech. E. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. Price 9s. net.

Mechanics of Air Machinery. By Dr. Julius Weisbach and Professor Gustav Herrmann. London: Crosby Lockwood and Son, 7, Stationers' Hall-court, Ludgate-hill, E.C. Price 18s. net.

Elementary Electrical Engineering in Theory and Practice. By J. H. Alexander, M.B., A.I.E.E. London: Crosby Lockwood and Son, 7, Stationer's Hall-court, Ludgate-hill. Price 3s. 6d. net.

Fire Tests with Partitions. Erected by the National Fireproofing Company. The British Fire Prevention Committee's Report. Published at their offices, 1, Waterloo-place, Pall Mall. Price 2s. 6d.

Telegraphy: A Detailed Exposition of the Telegraph System of the British Post-office. By T. E. Herbert, A.M. Inst. E.E. London: Whittaker and Co., 2, White Hart-street, Paternoster-square. Price 6s. 6d.

The British Trade Year Book, 1905: Covering the Twenty-five Years 1880-1904, *and showing the course of Trade.* By John Holt Schooling. London: John Murray, 30, Albemarle-street, W. Price 10s. 6d. net.

The Guide to South Africa. By A. Samler Brown and G. Gordon Brown. 1905-1906 edition. London: Sampson Low, Marston and Co., Limited, St. Dunstan's House, Fetter-lane, Fleet-street, E.C. Price 2s. 6d.

Fire Tests with Doors. A steel rolling shutter door known as the "Kinnear" door, fixed by Messrs. A. L. Gibson and Co., London. London: The British Fire Prevention Committee, 1, Waterloo-place, Pall Mall. Price 2s. 6d.

Practical Trigonometry for the use of Engineers, Architects, and Surveyors. Second edition. By Henry Adams, M. Inst. C.E., M.I. Mech. E., F.S.I., &c. London: Whittaker and Co., 2, White Hart-street, Paternoster-square. Price 2s. 6d.

THE CRUISER RACE.

Fuller details of this interesting event are as follows:—The ships taking part were—

Name.	Displacement.	Horse-power.	Boilers.
Drake	14,100	30,000	Belleville
Cornwall	9,800	22,000	Babcock
Essex	9,800	22,000	Belleville
Bedford	9,800	22,000	Belleville
Berwick	9,800	22,000	Niclausse
Cumberland	9,800	22,000	Belleville

All have a designed maximum speed of 23 knots at full power.

Before leaving New York all ships were coaled to the full capacity. As there was not sufficient Welsh coal available, the flagship Drake, record holder of all previous races, was ordered to fill up with American coal—a handicap which created great satisfaction in the squadron. The ships steamed at easy speed to off Sandy Hook, where the signal was made "make your way independently to Gibraltar at greatest speed with the coal on board"—2500 tons in the Drake, and 1600 tons in the other ships.

At 1.30 p.m. on the 20th November the ships formed in line off Sandy Hook, received the order to start, and up to the evening of the 24th kept practically all together, the positions being:—

	Ship.	Distance astern of next ahead.
1	Drake	—
2	Bedford	2,000 yards from 1
3	Berwick	2,000 yards from 2
4	Cumberland	1,500 yards from 3
5	Cornwall	12,000 yards from 4
6	Essex	8,000 yards from 5

At noon on the 25th the positions were as follows:—

1	Drake	—
2	Berwick	5 miles from 1
3	Bedford	
4	Cumberland	All about 10 miles astern
5	Essex	
6	Cornwall	

At 3 p.m. on the 25th the Bedford develcped hot bearings in the port engine, and had to stop that engine for a couple of hours, and so got hopelessly left astern.

In the afternoon of the next day, 26th, the order was:—

1	Drake	—
2	Berwick	3 miles from 1
3	Cumberland	
4	Cornwall	All about 12 miles astern
5	Essex	

On the evening of the 26th most ships had used up their normal coal, and great difficulty was experienced in getting at the reserve supply. All officers and deck hands not on duty volunteered for getting coal out of the reserve bunkers.

At daylight on the 27th the positions were:—

1	Drake	—
2	Berwick	3 miles from 1
3	Cumberland	
4	Essex	About 9 miles astern
5	Cornwall	

In all the ships coal was now getting very short, and everything depended upon getting it to the furnaces. The amount of coal remaining was:—

Drake	305 tons
Berwick	256 "
Cumberland	297 "
Essex	317 "
Cornwall	240 "

During the 27th the Cumberland began to creep steadily up, and in the afternoon the positions were:—

1	Drake	—
2	Berwick	1 mile from 1
3	Cumberland	½ mile from 2
4	Cornwall	Well astern
5	Essex	

Five minutes after midnight the Drake passed Tarifa Point, the Berwick being 1600 yards astern of her, and the Cumberland a little astern again. The other two ships were out of sight, having given up the struggle to a certain extent on account of the difficulty of "scraping bunkers for coal dust."

The Drake's time for the whole run was 7 days 7 hours 10 minutes, being an average speed of 18·504 knots for the entire trip. For the first few days a much higher rate was maintained, but towards the end a heavy fall in speed brought down the average in all the ships. All the ships burned coal heavily; it was shovelled on without regard for the usual economical rules. On the fourth day out the Drake suffered a good deal of trouble from her American coal, which exhibited a poor calorific value compared with Welsh coal.

OBITUARY.

ROBERT MANSEL.

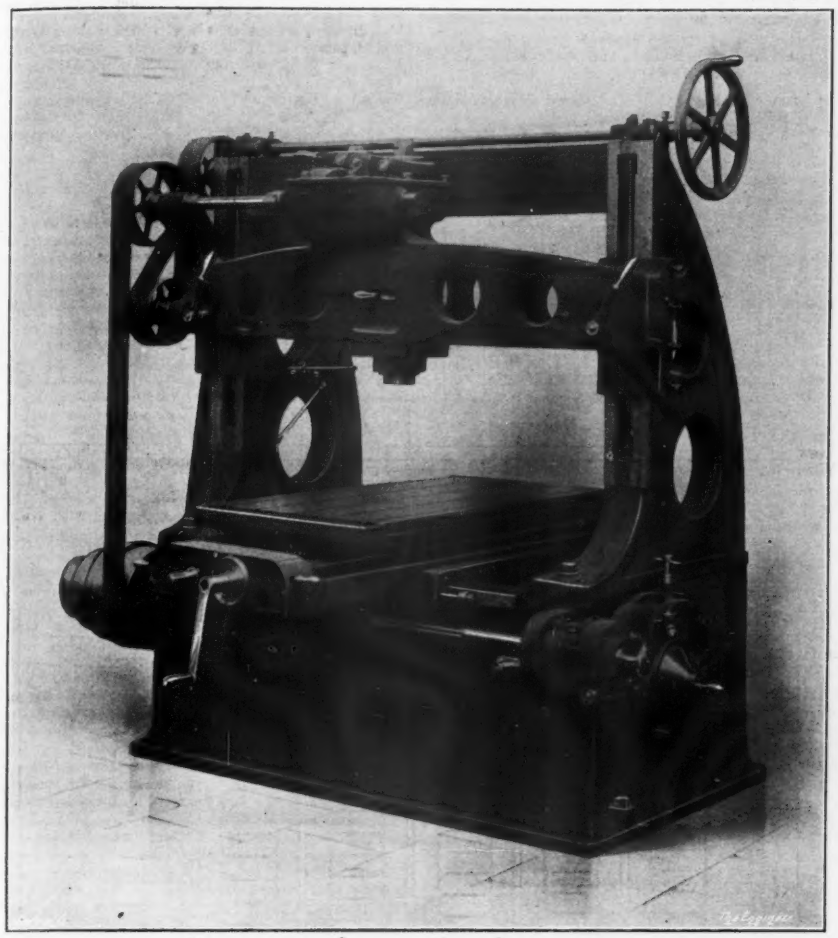
The death has taken place, in his eighty-first year, of Mr. Robert Mansel, of the formerly well-known shipbuilding firm of Aitken and Mansel, Whiteinch and Kelvinhaugh. Mr. Mansell was born at Glassford, near Strathavon, Lanarkshire, in 1826, and in his youth attended the Andersonian University and the Mechanics' Institution, Glasgow, in both of which institutions he was a distinguished student. Later on he attended the mathematical and natural philosophy classes of Glasgow University. He was the first student to be enrolled in the natural philosophy class of Sir William Thomson—now Lord Kelvin—on his appointment to that chair, and at the close of the first session was appointed to be experimental assistant to that distinguished professor. After completing his studies under Professors Gordon and Macquorn Rankine, both eminent exponents of civil and mechanical engineering, Mr. Mansel entered the service of Messrs. Robert Napier and Sons, in their shipyard at Govan, where he acquired a practical knowledge of iron shipbuilding, and in 1850, while still a young man, was appointed naval architect to the firm. He held this position for about thirteen years, being intimately connected throughout that period with the design and construction of the various mercantile and war vessels constructed by the Napier firm, including such notable steamers as the Persia and Scotia, and the armoured frigate Black Prince, the first war ship of any importance to be launched on the Clyde. During the early part of his connection with this firm, one Admiralty contract on hand consisted of some fifteen or twenty gunboats for Crimean service. In 1863 Mr. Mansel joined Mr. James Aitken in establishing the shipyard at Whiteinch. During the course of its nearly thirty years' existence the firm of Aitken and Mansel produced a large number of steamers, of various types, for a large number of companies. Among the notable vessels constructed were the Tartar and Athenian for the Union Steamship Company's South African service, which in their day were considered crack vessels. Other companies for which the firm built were those of Gellatley, Hankey and Sewell, and the London and South-Western Railway Company. For the latter company they built almost all the earlier steamers, including the ill-fated Hilda, which was wrecked recently, with lamentable loss of life, off St. Malo. During the tenure of their yard at Whiteinch the firm conducted a branch establishment at Kelvinhaugh, and after a time at Ardrossan. After the closing of the firm's yard at Whiteinch, in 1890, Mr. Mansel retired from active professional life, and almost since that time has been little heard of in the circles in which he formerly was so well-known.

The theory and science of his profession had always, up to the last almost, a fascination for Mr. Mansel which was absolutely engrossing; and the resistance and speed of ships formed one branch of investigation, and keen study, which he resolutely pursued and painstakingly laboured at, as evidenced by his contributions to our own pages. A notable contribution to the scientific knowledge and methods of analysis connected with progressive speed trials, which was the outcome of a dispassionate difference between him and the late Mr. William Denny, of Dumbarton, involving the work and reputation of the late Dr. William Froude, is still well remembered by the members of the Institution of Engineers and Shipbuilders, of which body Mr. Mansel was one of the original founders. He became a member of the Scottish Shipbuilders' Association in October, 1864. This Association was amalgamated with the kindred institution of the Institution of Engineers in Scotland, which had been in existence since 1857, the amalgamation being brought about in 1865. Mr. Mansel took a goodly share in the proceedings of the joint institution for many years, and was president for 1878-80. A few years after the firm of Aitken and Mansel had ceased to exist, a son of Mr. Mansel's went to South Africa, and, in the hope that the change would recruit his own health, Mr. Mansel himself proceeded there and remained for some years. He returned about five years ago, and for a time lived at Penge, London, and subsequently at Dunblane, Scotland, where he died. He is survived by a widow, two sons, and a daughter.

The long-proposed extension of the Burlington Railroad from Billings to Great Falls will soon be constructed. The road will connect the Burlington road with the Great Northern system in Montana.

VERTICAL MILLING MACHINE

G. RICHARDS AND CO., LIMITED, BROADHEATH, ENGINEERS



VERTICAL MILLING MACHINE.

WE recently had the pleasure of examining a vertical milling machine with a duplex drive to the spindle, which we believe to have been originally designed for milling motor parts by its maker, G. Richards and Co., Limited, Broadheath, near Manchester. The general construction of this machine is so clearly shown in illustration that very little description is necessary. The spindle drive is by gear wheels or worm, and the speeds, twelve in number, vary from 9·6 to 432 revolutions per minute, so that the machine is adapted for doing brass as well as iron milling. The table has sixteen feeds, from ·083in. to ·005in. per spindle revolution for use with the fast drive, and ·166in to ·01in. for use with the slow drive. The machine, which we examined, was carefully machined and fitted, and a great deal of thought has evidently been spent on the design of this tool. The spindle has a vertical adjustment be means of the cross slide, as shown on the illustration, as well as a fine adjustment of ¾in. range, so that it is adapted for accurate thicknessing.

RUSSIAN RAILWAY FINANCES.

WHILE the Russian railway system is divided usually into three groups, namely, into lines owned by the State, into lines owned by private companies, and into short local lines, the Government financial officials see fit to divide Russian railways into another threefold group. To the first group under this scheme belong all those lines which yield a net profit sufficient to pay off the interest upon, and the redemption bonds of, the capital laid out in building them; the total length of these solvent lines in 1903 was 13,801 miles. The second group consists of those lines which do not make enough net profit to pay the interest due and redeem the bonds issued to raise the money for laying them down; the length of these lines in 1903 was 6267 miles. To the third group belong the lines which are run at a loss, for their receipts do not cover their working expenses; in this profitless group there are four lines, the Siberian Railway, the Trans-Baikal Railway, the Ussuri Railway, and the Ssysran and Vyasma line, a total length of 4505 miles. According to the Imperial Comptroller's returns, the working of the Russian State railways in 1903 entailed on the Exchequer a loss of £2,006,046, and the private railways a loss of £178,633. This total loss of £2,184,679 was due mainly to the deficits on the four railways mentioned in the third group. To meet these deficits the State advanced the sum of £1,215,916, while the sum of £2,097,378 had to be taken into account for paying the interest due on the capital outlay. Thus the total loss on these four railways in 1903 amounted to £3,313,294. Ten years ago a change for the better seemed to have come over the working results of the Russian railways, which for many years had entailed only loss to the Government. Thus, from the State and private lines the Russian Government received in 1895 a profit of £191,250, of £1,200,625 in 1896, of £318,750 in 1897, of £924,375 in 1898, and of £127,500 in 1899. But then the lean years set in, and the Russian Government has had to renew the making of yearly advances to meet both the payment of interest and to pay the loss incurred by various private railways. These advances have been: In 1900, £286,875; in 1901, £3,740,000; in 1902, £4,250,000; and in 1903, £2,188,350, or a total loss of £10,465,225. However, this unsatisfactory state of affairs is not due altogether to the losses incurred by the four railways referred to. It must be borne in mind that railway construction in Russia has always been costly, and of recent years the outlay on laying down new lines rose to such a height that only the most sanguine person could expect many of the lines to yield a profit, even if they could be made to pay their way for many years to come. To make the outlook still gloomier, the recent strikes on all the Russian railways are leading to an increase of the wages of all ranks, and this increased expenditure, coming at a time when there is such a general paralysis of trade in all parts of the Russian empire, must result in the State having to make further increased advances to a greater number of lines. Moreover, these strikes have entailed, up to the end of November, a loss of £3,931,250. In Prince Khilkoff, Russia has had a most able Minister of Ways of Communication during the very trying period of the recent war with Japan. He has set his face against the laying down of strategic and military railways, which certain Russian statesmen delight in seeing either on paper or laid down, and if he were allowed to carry out Count Witte's wishes with regard to improving and extending the railway system of European Russia in those regions in which railroad communication is really called for, then the Russian railway system might pay its way, while it certainly would benefit the empire far more than is the case in these days.

NEW BRIDGE OVER THE RIVER SPREE.

A NEW bridge recently erected over the river Spree at Oberschönewiede, not far from Berlin, is sufficiently characteristic of the German type of construction to render interesting a brief description of it. Under the name of Treskow-Brücke, it crosses the river at an angle of 71 deg. 10 min. It consists of three spans, including a central of 257ft. 6in., and two side spans of 123ft. 9in. each. It was necessary, in the interests of navigation, to provide for a headway in mid-channel of 15ft. between high-water mark and the soffit of the platform. The approaches to the bridge are consequently upon gradients of 1 in 70. A double track electric tramway is laid symmetrically with respect to the longitudinal axis of the structure, with a distance of 16ft. between each track. This space is utilised for the roadway, which, including the tramway, has a total width of 25ft. between kerbs.

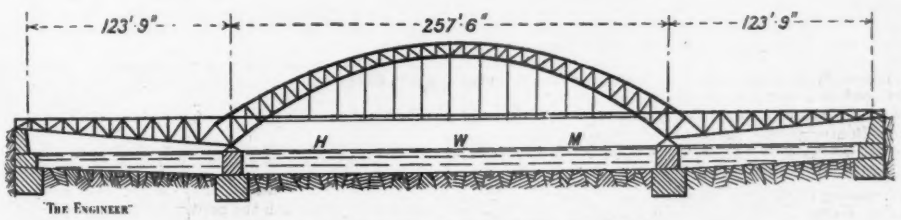


Fig. 1—THE TRESKOW BRIDGE OVER THE SPREE

The main girders, shown in skeleton elevation and section in Figs. 1 and 2, are placed 29ft. apart from centres, leaving transversely a clear distance of 26ft. Outside the main girders the footpaths are carried on small cantilevers—Fig. 2. Between parapets, the total width of the bridge is 48ft.; the navigable width of the central channel of the Spree at this part of its course is 230ft., which, apart from other considerations, was the chief factor in determining the dimensions of the principal span. Neglecting for the moment the side spans, the design of the larger appears at first sight—Fig. 1—to bear considerable resemblance to the bowstring class. In reality, it may be said to consist of an open-web arch, of which the thrust is taken by the lower tie member, supporting the flooring and loading, and suspended from the arch by the vertical ties, as in the case of the inverted type, the suspension bridge. The absence of bracing between the arch and the horizontal tie, essential in the instance of rolling and uniformly distributed loads, also serves to distinguish it from the true bowstring. A very handsome bridge of this type spans the North-East Canal, near Trünenthal. The arched girderhas a bold stretch of 516ft., and the form of a crescent.

In the present example the main tie does not terminate at the ends of the arch, but extends for 15ft. beyond the

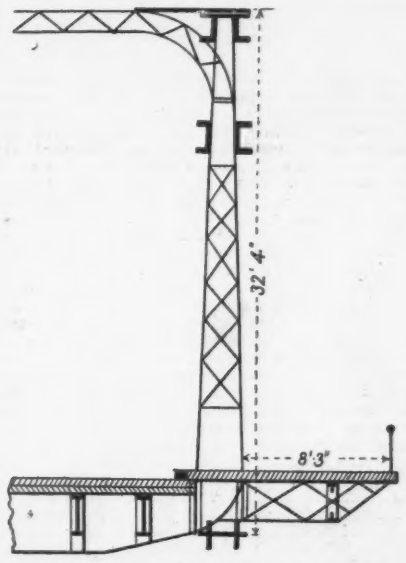


Fig. 2—MAIN GIRDER, TRESKOW BRIDGE

piers in the direction of the side girders. Under these the headway required is comparatively small, so that they can be placed beneath the loading, always the most favourable position for both principal and cross girders. In one sense the structure may be considered as continuous over four supports, but, so far as the dead load is concerned, it may be regarded as constructed on the cantilever system. For this purpose the separate members composing the web of the arch, near the piers, was not riveted up until the flooring and roadway were complete. As an extra precaution, to obviate all chance of a negative reaction occurring at either of the abutments, anchorages have been provided. There are in the whole superstructure 930 tons of mild steel. The masonry cost £5500, the steelwork £12,500, the roadway £2000, and the sum of £5400 expended upon the approaches and purchase of land brought up the total to £25,000. The bridge was designed by M. Karl Bernhard, of the Polytechnic School of Charlottenburg.

THE PAVING OF ROADWAYS.

ON Thursday, the 23rd ult., a paper was read before the Tramways and Light Railways Association by Mr. Walter L. Green on "The Paving of Roadways." The author commenced by giving a short history of the early methods of road-making, briefly following the progress made up to the present time. The Macadam era was dealt with at greater length. The author stated that Macadam laid it down as a principle that a road ought to be considered as an artificial flooring forming a strong, smooth, solid surface, at once capable of carrying great weights, and over which carriages might pass without meeting any impediments. The system adopted by Macadam was to spread broken stones, 2in. diameter, equally, so as to form a layer about 10in. thick over the road surface, after it had been levelled and properly drained. This system was applied principally to roads already made, and no new

in Switzerland and other countries, and such roads were very extensively laid in different foreign countries long before they were introduced here. The next development in road-making was effected by Telford, who did his first work in this direction on the Highland roads of Scotland, and no less than 920 miles were laid out under his direction. His method was to lay "on dry-bottomed ground, gravel of a proper quality, out of which all stones above the size of a hen's egg shall have been previously taken to a depth of 14in. in the middle and 9in. at the sides. The stones which are taken out of the gravel and do not exceed 4in. in size may be laid for that thickness below the gravel, and in that case 10in. only of cleansed gravel will be required." Telford also gave great consideration to the question of drainage. Since this period little change in the manner and method of paving has been made until recently, when new forms of paving material began to be introduced, and modern requirements demanded qualities and conditions not previously insisted on. Tar macadam is considered by many to be an entirely new innovation. But this is not so. Mr. Arthur Brown, the borough engineer for Nottingham, in a paper read before the Association of Municipal Sanitary Engineers and Surveyors in 1884, referred to a tar macadamised road in Nottingham which was laid down in 1840. However, the system has been greatly improved during the last few years. The advantages of tar macadam over ordinary macadam are:—Economy in upkeep; the insuring of a solid surface; and the prevention of dust. It will be recognised how liable to the production of dust and mud ordinary macadam is when it is stated that in one mile of roadway of 10 yards width no less than 600 tons of sand or similar material is used as the cementing agent to bind the stone together. Tar macadam is laid as follows:—

The granite or limestone is, after being broken to the proper sizes, treated with a composition of tar, &c., which penetrates below the surface. This acts as a preservative and as a deterrent of dust, seeing that the material is not affected by climatic influences; and it should form a very sanitary paving. The roadway itself is formed of three layers of material. The foundation consists of stones of about 2½in., laid to a depth of 4½in. to 5½in. This is thoroughly rolled, and another layer put on with stones gauged to pass a three-quarter ring, and this, after being rolled, is followed by a grouting of ⅜in. material. The whole surface is then rolled until thoroughly consolidated, so that a solid mass of tarred macadam is the result. During the past few years different methods have been introduced for treating the material by immersing in tar or pitch, while the system of laying has also undergone considerable change. It is, however, still known as macadam, although the material employed is now frequently limestone or slag, instead of granite. A new method of armouring macadam roads has been introduced into this country by Messrs. Brunton and Trier. The advantages claimed for this method include:—(1) Durability; (2) absence of dust and ease of cleansing; (3) excellent foothold; (4) reduced resistance to traction; (5) noiselessness; (6) low first cost—about 5s. per square metre. The inception of the system is due to Baurath Gravenhorst, of Stade, in the province of Hanover, who many years ago showed that the destruction of road metal spread in the usual manner is chiefly caused by the stones, which vary greatly in shape and strength, crushing each other under the pressure of the traffic. To avoid this, he selected stones of approximately equal size and cubical shape, and placed them singly side by side on the carefully levelled and rolled surface of the old road.

The result was a mosaic-like covering which proved to be of extraordinary durability. The next step was to increase the size of the stones and make them specially for the purpose, the two sizes now in general use being 3½in. by 4in. and 4in. to 4½in. in depth. It is important that the depth of the stones should not vary much, otherwise no great regularity is required, even stones with triangular heads being used. After removing as little as possible from the surface of the road, it is levelled and rolled, and the stones placed in position, sand being used sparingly and only for the purpose of bringing up the shallow stones to the level of those of full depth. Sand is then spread over the surface and allowed to remain for some days, so as to work into the joints. Many roads of this description that have been laid down in Wiesbaden for six years, are said to show no signs of wear yet. Whilst in other parts of Germany there are similar roads with a twelve years' record. The author also dealt at some length on asphalt and wood paving. With regard to the latter he explained that the woods now in general use for paving are deal, pine, the West Australian hard woods, Jarrah and Karri, and Blackbutt, a New South Wales wood. The principal properties of the Western Australian woods are—Karri, a hard, heavy, pale red in colour, with very little absorptive power; the fibres are strongly interlaced, and it is said to be of great tensile strength. Jarrah is a heavy hard wood slightly redder in colour than Karri. It has very little absorptive power, and is very durable and tenacious. It is, consequently, suitable for wood paving. These two woods are similar in appearance, and the method of distinguishing one from the other is by burning, Jarrah leaving a black cinder and Karri a light coloured ash. The life of these woods differ considerably according to their treatment and the conditions under which they have been used. The London County Council has fixed the period of ten years for loans for this description of paving, although many instances have occurred where they have been known to last longer than this on the roadway, and to have then been taken up, cut down, and relaid in another thoroughfare.

As representative of the cost of laying down and keeping in repair 1000 square yards of this hard wood, Mr. Oxtoby's—the borough engineer of Camberwell—figures were quoted:—First cost: 1000 yards super. 3in. wide by 9in. long by 4in. deep Jarrah wood paving, upon and including 6in. Portland cement concrete foundations, £750; contingencies, £50—total first cost, £800. Cost every ten years: 1000 yards super.—Taking up old blocks and repave with new 3in. by 9in. by 4in. Jarrah wood blocks, on old concrete foundations re-floated, at 12s. 6d., £625; contingencies, £75—£700. Blackbutt, a New South Wales wood, has been employed to some extent in this country, but, according to the author, for too short a period accurately to judge its suitability for paving streets. The dry weight of the wood varies from 56 lb. to 59½ lb. per cubic foot. Its absorptive power is about 5 per cent., whilst the expansion and contraction is said to be very slight. Blocks of Blackbutt and Hardwood, subjected to the heaviest class of traffic for twelve years, showed wear at the rate of $\frac{1}{10}$in. per annum. After briefly discussing cement concrete foundations, the author concludes his interesting paper with a few remarks on the wear of roadways. He stated that it had been shown that the wear is greater when light vehicles are being driven at high speeds than in the case of horses drawing heavy loads in heavy vehicles. The wear and tear of every vehicle of speeds of eight miles an hour and upwards is enormous, as compared with what it need be. It is the light vans, carrying one to one and a-half tons on 2in. tires, and drawn by trotting horses, that do more mischief than any other class, excepting the omnibus.

A MACHINE FOR ROLLING CORRUGATED SHEETS.

IN our issue of October 30th, 1903, we illustrated and described a mill for rolling reverse curves, which was designed by Mr. Godfrey B. Johnson, of 8, Victoria-street, Westminster. Since the appearance of that article, Mr. Johnson has developed the machine in another direction, and we are now able to give a description, with details, of a mill which he has constructed to roll corrugated sheets. It will be remembered that the function of the first machine was to roll, longitudinally, sheet metal strips to a curved, reversed curve, or other section. It also dealt with the formation of curves such as are found on half-round and rectangular gutters, astragals, sashbars, troughing for cables, and zinc mouldings of various descriptions. But the main object of the machine was to roll straight such sections as those mentioned to any length required. The object of the present invention is to enable a machine of this type to be employed for producing shapes comprising a large number of reverse curves, and for bringing sheets of metal of any width to a corrugated cross-sectional form, such, for instance, as is commonly required in sheets for roofing, whether the sheets require to be flat or curved longitudinally.

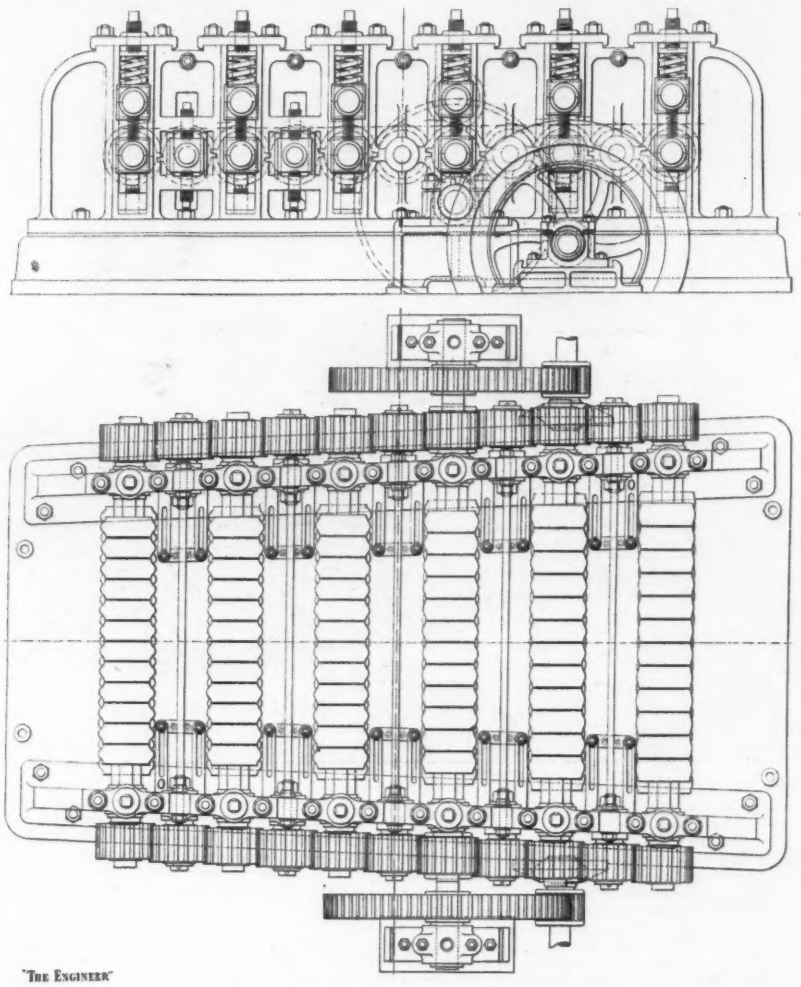


Fig. 1—CORRUGATED SHEET ROLLING MILL

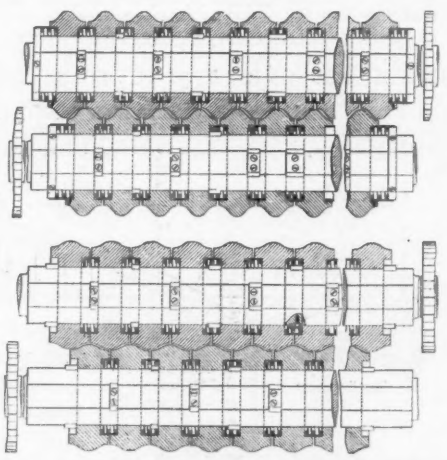


Fig. 2—ARRANGEMENT OF ROLLERS

Diagrammatic illustrations of the machine are given in Fig. 1. It consists of a heavy frame, upon which are carried twelve perpendicular brackets—six on each side—spaced an equal distance apart. These brackets form guides for any vertical movement of the roller spindles. Springs are used to keep the top roller pressed hard against the lower roller. The rollers for producing the contours of reverse curvature consist of cones of various forms—to suit the different sections that it is required to produce—independently fixed to the spindle and held apart at predetermined distances by spring pressure. This arrangement is clearly shown in Fig. 2. The successive pairs of rollers, which gradually diminish in width, are mounted nearer together in the successive rolls, so as to correspond with the uniform gradual diminution in the effective width of the metal sheet, during its passage through the mill. Owing to the concurrent deepening of the corrugation the cones approach one another simultaneously with the passage of the sheet. The rollers are adjusted so that the sheet is prepared as it leaves one pair of rollers for entry between the next pair. The maximum diameter of the cones all having an equal surface velocity, the sheet is fed forward at the same speed throughout, and is thus not subjected to tensile or buckling stress whilst under treatment. The metal has a gradual continuous process of bending without suffering from any violent or sudden stress.

To ensure equality in the rate of feed through the mill in cases where reverse curved contours are of a depth in relation to their width, any peripheral zone of a roller that might retard or accelerate the feed action produced by a co-acting zone of another roller may be mounted to turn idly on its spindle. It was thought that it would probably be necessary to adopt some device for keeping the sheet in line. In order to permit of this being done, anti-friction guides were fixed to the mill. They have, however, proved to be unnecessary, as, it is said, the central cone of the top set of rollers being fixed to the shaft, the sheet is kept in line. The machines can be either motor or belt driven. There are two large flywheels, one on each side of the machine. Pinions are keyed on their shaft, which gear into a larger wheel on a countershaft, a pinion on which gears with toothed wheels on to the spindle of the lower roll of the third set. This transmits motion to both the upper and lower sets of rollers simultaneously. This explanation will be more readily understood by referring to the side elevation given in Fig. 1.

Turning to the capacity of the machine, it will be gathered from the accompanying table that, accepting the estimate as correct—and we have no reason to doubt it—this is considerable. Further, the inventor is of opinion that if the mill is belt fed, it could be driven at 60 revolutions per minute, instead of 30, as given in the table.

Estimated Output of One Rolling Mill.

Revolutions per minute.	No. of sheets fed at a time.	Gauge.	Feet per day (approximately).	Tons per day (approximately).	Tons per year (approximately).
30	1	16	40,500	114·5	34,350
30	2	18	81,000	192·8	57,840
30	1	20	40,500	78·3	23,490
30	2	20	81,000	156·6	46,980
30	3	20	121,500	235	70,500
30	3	22	121,500	189·8	56,940
30	4	24	162,000	216·9	65,670
30	4	26	162,000	180·8	54,240
30	5	28	202,500	150·6	45,180
30	6	30	243,000	162·6	48,780

The approximate average output per day for—taking 22 gauge sheets fed three at a time—would be 189·8 tons, or allowing for intermittent feeding, the average annual output—300 days

—would be 54,000 tons, and the average output for a day of ten hours would be 180 tons.

The designer emphasises the followed points in connection with his machine:—(1) That there is a great saving of time, enabling manufacturers to give quick delivery and to get better prices in consequence; (2) that "spoils" are avoided, as the alignment is true, and the fibre of the sheet is free from rupture or strain; (3) that the machine occupies only a small amount of floor space, 16ft. by 9ft.; (4) that there is a considerable saving in power, the mill absorbing, it is said, not more than 4 horse-power; (5) that the question of length is no object; (6) the percentage saving is estimated at fully 90 per cent. over other methods.

We may say that we have had an opportunity of seeing the machine at work, and have seen one, two, and three sheets rolled together. We thoroughly examined the sheets after they were rolled. They were quite straight and even, and there was no appearance of any straining. We may say that there is no difficulty in curving the sheets to any desired radius as they leave the machine.

CHAIN CABLE GROYNES.

A NOVEL method of protecting the foreshore against erosion, due to the encroachment of the sea, has been adopted by Mr. Allanson-Winn, of 22, South Frederic-street, Dublin. This new method consists in using heavy chain cables, to which are attached thorn bushes, or other suitable materials. The groynes are erected at right angles to the shore-line, and are held in position in deep water by concrete blocks or anchors, and on the shore by means of strong iron pins driven in between the links of the chain. The groynes are said to accommodate themselves very well to the contour of the shore and sea bed, and it is claimed that they catch sand, gravel, and shingle remarkably well. During the short time they have been in use they appear to have given satisfactory results. The illustration Fig. 1 shows the form of the groyne. A B C D E F is a section of the shore from the lowest point, where the sea end of the cable is anchored or fastened to a heavy block of concrete at A, and secured to a strong pin at B, near low-water mark, up to the top of the cliff F. The shaded portion indicates the sectional area of that part of the groyne composed of crates, trees, bushes, &c., which influence the currents and encourage the collection of travelling material. Concrete sinkers are used when the chain is light. These are placed at *a b c d e*. The dotted line shows the accretion which may be expected by the adoption of the groyne, low-water mark having been caused to retreat from B to B^1, and high-water mark from C to C^1; and the portion between the heavy lines shows the covering of sand, gravel, or shingle.

Ten of these groynes were recently erected on the foreshore at Bray, near Dublin. The shore line faces due east, and at this particular part of the coast the conditions are very unfavourable to any protectional devices. A triple line of railway depends upon the stability of the sea wall, which is constantly in danger of being undermined, and has always been a source of anxiety. The L.W.M. comes close up to its face, and the marl on which the foundations rest is frequently exposed to the sawing action of the heaviest travelling shingle. The chain cable groynes were placed in position before the end of last September. They are only about 100ft. in length, commencing at about M.S.L., and extending beyond ordinary low-water. They are pinned down to the marl with strong iron bars, pointed and capped, and the equinoxial gales which came with great force from the north-east failed to dislodge them, but brought in considerable quantities of sand, gravel, and shingle, which, it is said, still remain. The illustrations we give show sections of the foreshore. In each case the lower line shows the state of the shore on September 16th, and the upper line the contour on October 27th. The first section was taken 100ft. to the south of the first groyne, and the others midway between the groynes, which are in each case spaced 130ft. apart. After November 1st, the wind changed, and there was some rough weather, but no damage was done. In fact, it is said that more material came in in the neighbourhood of the last groyne. In Section V., taken at the end of the work, between groynes 8 and 9, although levels were taken for a horizontal distance only slightly exceeding 30ft., still this is sufficient to show what a large layer of material has accumulated on that portion of the shore, and how well the base of the wall is now covered. In this instance the shore-level has been raised from over 4ft. below H.W.L. to about half a foot above H.W.L. Mr. Allanson-Winn is of opinion that, as the groynes have stood such a severe test at Bray, they may do even better on shores where there is more sand and gravel, and less of the very heavy boulder shingle—some of the rounded blocks weighing over 80 lb.—which characterises the Irish coast round Bray Head. The advantages claimed for this type of groyne include:—(1) The adaptability of the flexible hedge to the inequalities of the surface of the sea bed; (2) impossibility of loss through being carried away, and the ease with which they can be removed; (3) small initial cost; (4) rapidity of construction; (5) cheapness of maintenance; (6) immunity from the attacks of ship worm; (7) indestructibility of the main portion of the groyne. Mr. Allanson-Winn considers that the groynes have now passed beyond the theoretical stage, and have shown practical and favourable results under particularly adverse conditions.

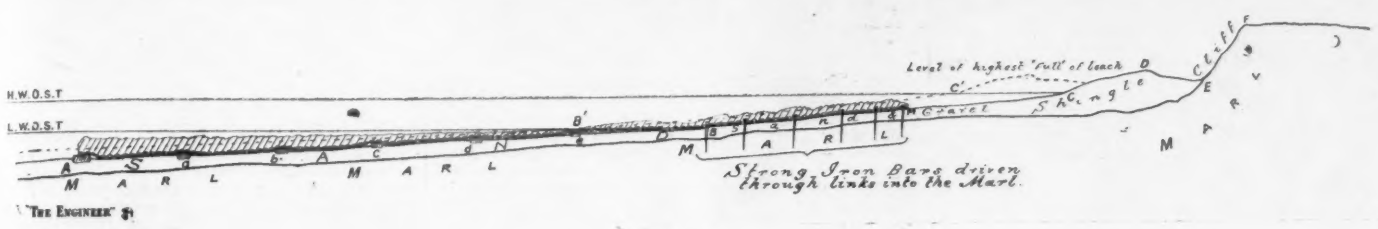
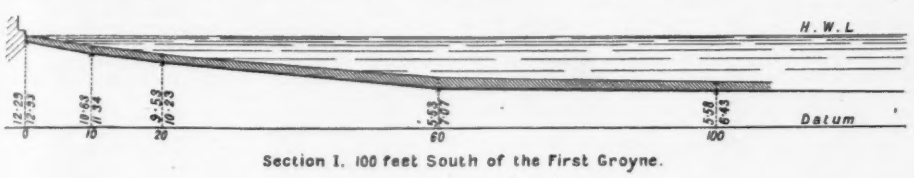
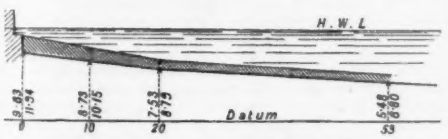


Fig. 1



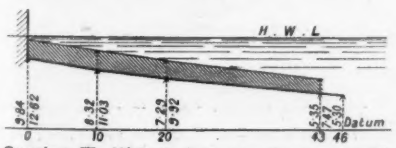
Section I. 100 feet South of the First Groyne.

Fig. 2



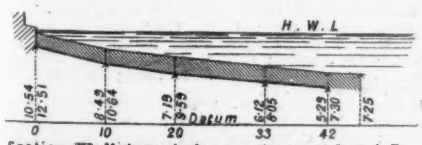
Section II. Midway between Groynes 2 and 3.

Fig. 3



Section III. Midway between Groynes 4 and 5.

Fig. 4



Section IV. Midway between Groynes 6 and 7.

Fig. 5

Fig. 1

Fig. 2

shape that a pawl is formed which can be bent, so that when it is screwed against the washer it engages with the teeth on the latter, a portion of the first-named plate being cut away so as to permit of this. The pawl, in engaging with the ratchet teeth when the nut is tightened, only allows of motion in one direction, *i.e.*, that necessary to tighten still further. To loosen, the pawl must be specially disengaged. The nut, therefore, is locked, since the washer cannot twist on its face because of the projections mentioned, nor the nut turn backwards, because it is held between the turned-up tongues of the spring plate, which itself is prevented from moving by reason of the ratchet and pawl.

We are informed that this type of lock nut has been in use now for some time, and that it has given satisfaction, having been extensively employed in motor construction.

Our illustrations will make the foregoing perfectly clear.

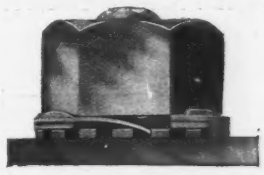


Fig. 3

Fig. 1 shows the washer with teeth stamped in its periphery and projections formed on its face; Fig. 2 shows the spring plate with its pawl and the two tongues which embrace the nut; and Fig. 3 the nut and washers tightly screwed up against some material. From this latter view the working of the whole combination will be readily understood.

DOCKYARD NOTES.

THE Atlantic Fleet is due at its home ports on Saturday next to give Christmas leave. The Channel Fleet comes in on the 20th for a similar purpose. It is estimated that there will be no less than fifty warships at Portsmouth during Christmas time and not many less at Devonport and Chatham.

THE monster battleships in hand for Japan have been named Aki and Kurama. They are to be launched in 1906. The armament is four 12in., twelve 10in., and twelve 4·7 guns, the displacement 19,000 tons.

OF the new Japanese cruisers laid down during the war, one, the Ikoma, has either been or is about to be launched. The other, the Tsukuba, will be launched early next year. It is proposed to build two sisters—Satsuma and Ibuki.

THE Russian battleship Pobieda, salved at Port Arthur, has been re-named Suwo by the Japanese.

IT appears that the ex-Russian ship Nikolai has been named Iki, and not Aki, as previously reported.

THE new United States battleships of the South Carolina class appear to be hanging fire. Naval officers wish to increase the displacement in order to carry more 12in. guns, but the majority of the Congressmen have other views. Some apparently consider that a far larger number of cruisers could be built for the same money, others demand "moderate dimensions," others something else. As none of them appears to have any personal knowledge of ships something novel and interesting may yet be arrived at.

THE recent fire at the Spanish Dockyard, in which the two torpedo boats Arieto and Rayo were burnt, reminds us that these two vessels, built by Messrs. John I. Thornycroft and Co., at Chiswick, in 1887, were the first war vessels fitted with water-tube boilers. They attained a speed of 26 knots, which, at the time they were built, was considered phenomenal. They were 147ft. 6in. long.

A NEW LOCK NUT.

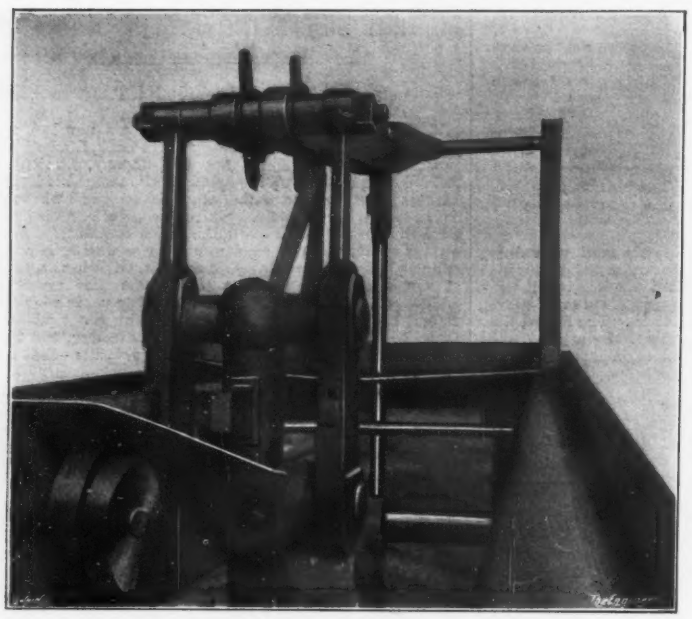
WE have lately had brought to our notice a new lock nut, which is manufactured by Sperling's Nut Lock, Limited, and of which the Consolidated Supply Company, Limited, of Canonbury, has taken up the agency. The method of locking consists in employing a washer of special form and what may be termed a spring plate. These are so constructed that when the nut is screwed down the whole combination forms what is practically one solid piece. The washer is of the ordinary size used for any particular bolt, but it has a number of square teeth stamped at equal distances round its periphery. In the particular example before us, in which the diameter of the bolt is ½in., there are thirteen teeth—and consequently thirteen spaces also—in the washer, the teeth being square in form. On one face of the washer—that face which is to come next to the material to be held—two excrescences are formed at opposite sides. These are intended to force their way into that material, the washer being of hard steel. It will be evident that, in consequence of these excrescences, when the washer is pushed against the material by the action of the nut it will not be able to move relatively to that material.

The spring plate comes between the nut and the washer. It is made up of two pieces. One of these is stamped with two tongues, one each on opposite sides of a diameter. These are turned up at right angles and pass through slots in the other plate, being so placed that they embrace the nut on opposite faces. The other plate has a cut in it of such a

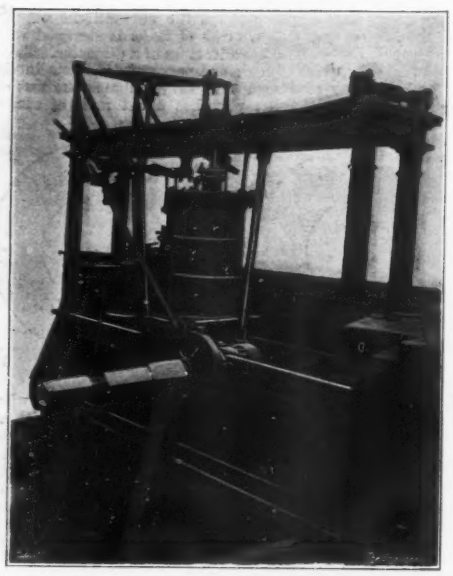
FRANCE has now in hand what, after Panama and Suez, is undoubtedly the greatest maritime canal project of modern times, and one that in its political and strategical aspects, probably eclipses all others, says the *Globe*. It is known to Frenchmen as the canal of the two seas, and its object, stated in a sentence, is simply to "abolish" Gibraltar, or in strict parlance, to "turn" that fortress by means of a ship canal, navigable by warships of the largest size, between Bordeaux and Toulon, thus letting the North Sea into the Mediterranean. Twice a Parliamentary Committee has studied the question in all its aspects, has inspected British and German canals, and has had plans and estimates prepared. Up to the present no decisive action has been taken, but another great effort is going to be made to impel the Chambers to a decision.

AN EARLY DREDGER.

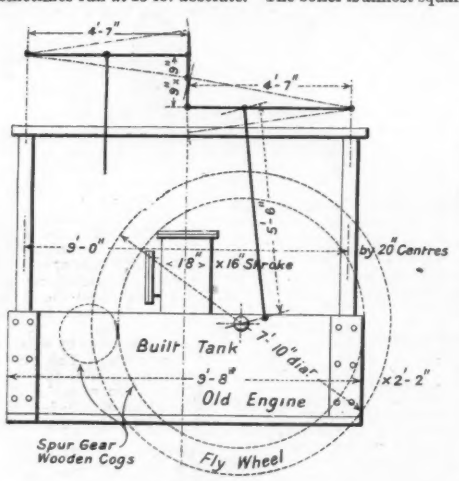
THROUGH the courtesy of Mr. George C. Douglas, of Dundee, we are enabled to give the illustrations of an early steam dredger which appear on this page. The vessel is supposed to have come from Glasgow, and has belonged to the Dundee Harbour Trustees for more than a century. It is built of oak, and is 68ft. long, with a beam of 21ft., and draws in working order 7ft. 6in. The engine is believed to have been built by Watt; the cylinder is 18in. diameter by 16in. stroke, and is double-acting. It is supplied with steam at a pressure of between 5 lb. and 10 lb., and being fitted with a condenser has sometimes run at 15 lb. absolute. The boiler is almost square in cross section, and measures 6ft. by 6ft. by 12ft. long. It has two furnaces. The safety valve is set to blow off at 10 lb. The slide valve is of the D type. The parallel motion is shown clearly in one of the illustrations, and the general arrangement in the other, whilst the principal dimensions are given in a sketch. We understand that the engine still works well. A good deal of interest is being taken in it, and it is hoped that it may be possible to secure it for one of the museums or colleges, possibly for Birmingham. If any of our readers are in a position to give us any further information about the engine we shall be glad to have it.



PARALLEL MOTION



AN OLD DREDGER ENGINE



DREDGER ENGINE

THE CORROSION OF CONDENSER TUBES.

THE corrosion of condenser tubes, more especially when used for marine purposes, is a difficulty which all engineers have to contend with. Failure of condenser tubes are a source of endless trouble and also considerable expense. In an interesting article written by Professor Humboldt Sexton which appears in the *Engineering Magazine* for this month, the author gives a summary of our present knowledge on this subject, and suggests lines upon which a further study should be made. It is assumed that the composition of the condenser tubes under consideration is 70 per cent. of copper and 30 per cent. of zinc. It is pointed out that three conditions generally prevail when tubes are removed from condensers. These conditions are:—(1) The tubes may be worn nearly uniformly, the thickness of the metal being considerably reduced, thinner in some places than in others. On making a section, the remaining portion of the tube appears to be of brass quite unchanged. (2) The tube may be considerably reduced in thickness, and, as before, to some extent uniformly, but there may be pitting here and there, and the inner surface of the tube seems to have become converted into copper—that is, it is dezincified—and this change in some cases may have gone to a very considerable depth. (3) The tube may have worn down very irregularly, dezincification being well marked, often in patches, and sometimes extending at various places quite through the metal, giving the appearance of small plugs of copper, which may be either firmly adherent or quite loose. Probably there will also be holes corroded through the tube, few or many as the case may be. These plugs of copper and the holes will usually lie almost in one line, which is at or near the bottom of the tube, when in position in the condenser. Tubes that are in the first condition will usually have worn well, and been in use for a long time. The second class of tube will have been fairly good, but those in the third condition will usually have had a short life, and probably have given much trouble. In all probability the tubes will contain a deposit. Sometimes they are almost clean inside; sometimes there is a thin skin of black material. In cases where the tubes have not been good, there is frequently a heavy deposit of a black or brown colour, which contains a large quantity of ferric hydrate. In all probability there will also be found a patch or layer of a green deposit irregularly distributed. Occasionally clusters of white crystalline needles or modules of white potash are found. Dezincification under the green deposit may be found frequently to occur. It must be remembered that the tubes under consideration are those used in marine work, in which case they are kept filled with sea water. The evidence is said to be quite conclusive that the sea water is the corroding agent; but, it is added, its action can be accelerated or retarded by the presence of other materials and by the conditions under which the tube is placed. At high temperatures both copper and zinc are very readily acted upon. Brass, which is an alloy of copper and zinc, often with the addition of a small quantity of tin, is also acted upon, but if of suitable composition, much less so than either of its constituents alone. Sea water contains a large amount of sodium chloride; there is also a considerable quantity of oxygen and of carbon dioxide in solution. There is no doubt but that the oxygen in solution is largely responsible for the corrosion, and that the carbon dioxide plays some part in it; but the presence of the latter is by no means essential, as corrosion will go on, though at a reduced rate, when carbon dioxide has been completely removed. In one case the deposit from a corroded tube was found to have the following composition:—

	Per cent.
Copper oxide	30·85
Copper chloride	3·20
Zinc oxide	30·80
Iron oxide	11·40
Insoluble matter	3·08
Organic matter, carbon dioxide, water	20·67

These figures are of importance, for they show that the deposit is basic chloride and carbonate of copper and zinc. It contains copper and zinc in nearly equal amounts, though in the tube the metals were in the ratio of 7 to 3. It must be also observed that there is a large amount of oxide of iron, as hydrate, insoluble matter, and organic matter, which could not have been derived from the tube itself, but must have been introduced from the outside. This, says Prof. Sexton, is the case in every sample of deposit from badly corroded condenser tubes that he has examined. The following is the analysis of another sample of deposit formed by the action of clean sea water on copper:—

	Per cent.
Copper carbonate	29·77
Copper chloride	8·89
Copper oxide	59·38
Water	2·46

The author then goes on to describe experiments that have been made, under various conditions, on the action of sea water on metals. From the results it appears that a considerable quantity of zinc was removed in solution or in suspension, from an alloy of 70 per cent. of copper and 30 per cent. of zinc. It is interesting to note that when brass contains 66 per cent. or less of copper the action is very different, the amount of copper removed being small, and the deposit nearly white. The latter consisted almost entirely of zinc salts. In a 66·/34 brass tube the ratio of zinc to copper dissolved was 146:1 in one case and 214:1 in another; whilst in a 50·50 brass only a minute trace of copper was removed. The author divides the actions by which a brass tube may be corroded into three kinds:—(*a*) General corrosion, in which the copper and zinc are removed practically together by chemical or electric action; (*b*) dezincification; (*c*) erosion, in which the metal is worn away by the mechanical attrition of the water. Corrosion of brass tubes is said primarily to take the form of dezincification. Whenever copper and zinc seem to be removed together, it is always because the spongy copper left by the dezincification has been removed by the mechanical action of the water, aided by solid matter, which may be in suspension. This reason is given to show why tubes which are worn away very uniformly show little sign of dezincification. It is well known that some condenser tubes last for a very much longer time than others. The reason for this is said to be either due to something in the nature of the tubes themselves, or to the conditions under which they have been worked. There is said to be no alternative, unless some occult cause is assumed to explain the somewhat erratic behaviour. The author himself thinks that the cause is to be found in the working conditions. The mechanical structure of the metal is sometimes held to be responsible for corrosion. It has been suggested that the crystals being differently oriented might set up galvanic action, so that the lines of junction of the crystals might become centres of corrosion. Dezincification bears no relation whatever to crystal structure. It is frequently contended that the larger the crystals the more rapid will be the corrosion. Prof. Sexton thinks that this has no influence whatever on the corrosion of the metal. To use his own words, he says: "I feel quite certain that the cause of variation in the durability of condenser tubes is not to be found in the chemical composition or physical structure of the metal, nor in any variation in the process of manufacture, nor in anything connected with the tubes." The solvent action of the sea water will account for the slow and steady dezincification which will ultimately wear away the tube; but this will take years, and something more is necessary to explain the irregular corrosion which is so destructive. It is admitted in the article that river water is more likely to accelerate corrosion than is deep sea water. From experiments that have been carried out it appears that a river water containing sulphides might cause a deposit of sulphides which, on the tubes being filled again with sea water, would set up corrosion, and, this being repeated day after day, vigorous corrosion might result. Professor Sexton says:—"I have come to the conclusion that rapid and irregular corrosion, as distinguished from that due to the normal action of sea water, is almost invariably due to electrolytic action set up by the contact of particles of substances electro negative to the brass, probably in most cases carbon. Cinders have been found in condenser tubes, and they frequently pass in from the outside, especially when they are thrown overboard from positions that will allow them to be drawn in. There is said to be no cure for irregular corrosion, at any rate after it has once fairly started. But, like many diseases, even if it cannot be cured, it can be prevented, and the author is strongly of opinion that it is always preventable. (1) The corrosion from the presence of solid particles can take place only if such particles are allowed to rest in the tubes. If the current be strong, therefore corrosion is little likely to take place, while if it be sluggish corrosion is very probable. (2) The tubes must be frequently cleaned, so that any deposit which is forming may be removed. This is of special importance in steamers running in foul rivers, which may readily pick up substances which may cause the adhesion of objectionable material. As has already been pointed out, tubes that have corroded badly are almost always characterised by the presence of a heavy deposit. (3) The tubes should never be left full of water when the steamer is at rest, but should be run dry and perfectly washed out with clean water as soon as the day's work is done. This, too, is said to be of great importance on steamers working on foul rivers where objectionable matter may be drawn in, which, during the period of rest, will settle to the bottom of the tube and form a lodgment from which it will not be displaced when work is resumed, and so corrosion may be set up, and once started it will go on rapidly under the deposit formed. Finally, the author states that he is quite convinced that if the condensers be well designed and these three precautions be taken, then very little will be heard of unduly rapid corrosion.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer Captains.—C. Lane, to the President, for service at the Admiralty; J. H. Adams, to the Vivid, as assistant to captain of R.N. Engineering College; and I. E. Hurst, to the Diadem, additional.

Engineer Commanders.—A. W. Turner, to the Nile; W. Hines, to the Cæsar, on recommissioning; Victor E. Snook, to the Sappho; Edward J. Egar, to the Duncan; James Ryan, to the Barfleur; Charles C. Sheen, to the Leviathan; G. T. Kerswell, to the Tamar; W. H. Wood, to the Devonshire; and E. A. Short, to the Ariadne.

Engineer Lieutenants.—J. Kelly and W. G. Main, to the Cæsar; H. C. Read, to the Nile, on recommissioning; W. A. Wilson, to the Harrier; F. Jarvis, to the Pembroke; T. O. Jameson, to the Victory, for the Brazen; William J. Dixon, to the Barfleur; Charles G. Ware, to the Duncan; Cecil Barker, Cecil L. Warren, Alfred Turner, all to the Leviathan; Herbert W. Irish and Charles P. W. Bartlett, both to the Spartiate; T. W. Richards, to the Sapphire, for the Wolf; G. W. Wooldridge, to the Russell; C. T. D. Greetham, to the Thames, for submarines, and J. E. Hayes, to the Pandora; C. J. M. Wallace, to the Vivid, for the Doon; T. Pearce, to the Hecla, for the Fame; and E. D. Mallinson, to the Vivid, for the Jed.

Engineer Sub-lieutenants.—A. Wild, to the Cæsar, on recommissioning; Harold H. Harvey, William E. Carter, both to the Duncan; Sydney C. Whyham, to the Leviathan; and L. P. Fowler, to the Encounter, on completing.

Artificer Engineers.—John Dornan, to the Duncan; Arthur Lavender, to the Barfleur; John J. McLeod and William Howes, both to the Leviathan; and Harold Fishlock, to the Spartiate.

Acting Artificer Engineers.—Septimus J. W. Richardson, to the Duncan; Edward A. Hood, to the Leviathan.

THE rubber industry in Ceylon is making rapid advances, something like 40,000 acres being now planted up with this crop.

WOOD-WORKING MACHINERY

JOHN PICKLES AND SON, HEBDEN BRIDGE, ENGINEERS

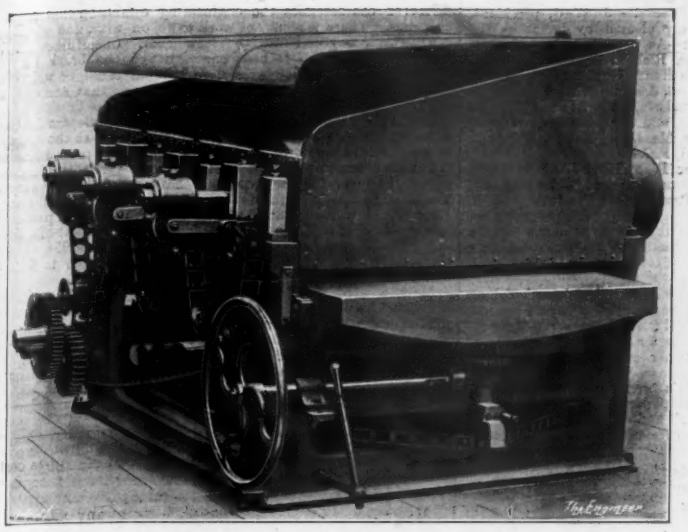


Fig. 1—SAND-PAPERING MACHINE

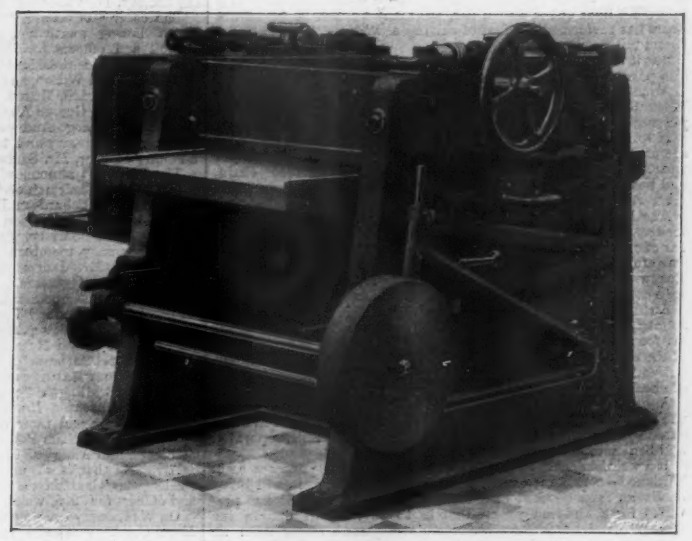


Fig. 2—PANEL SCRAPING MACHINE

WOOD-SCRAPING AND SAND-PAPERING MACHINES.

WE illustrate above two machine tools that have been made for the Indian State Railways by Messrs. John Pickles and Son, saw-mill engineers, of Hebden Bridge, Yorkshire. They have been constructed under the supervision of Sir A. M. Rendel, and will be used for the manufacture of railway carriages, frames, &c. One of these, a three-roller sand-papering machine, is illustrated in Fig. 1. This machine is for giving a finished surface to panels, doors, and other planed woodwork before the paint or varnish is put on, and it will take work up to 40in. in width and 4in. in thickness. It is built on what the firm terms its improved principle, which consists in having the drums on the top of the work, thus enabling a correct uniform thickness of the material being treated to be obtained, and also giving, it is claimed, a better finish to the work. The general features of the machine can be clearly seen in the illustration. There are three sand-papering rollers of special construction. Sand-paper of different grades can be readily attached to the drums and tightened. The drums have an oscillating movement, and the shafts upon which they are mounted run in phosphor bronze bearings. The drums can be raised or lowered whereby the pressure on the work, and hence the cut, can be varied. In order to remove any wood fibre that may have been depressed by the previous drum, as the work passes through the machine one of the rollers is run in an opposite direction to the other two. Further provision is also made for cleaning the material. This consists of a revolving brush fitted at the end of the machine. Four plain spring-mounted feed rollers, each driven by a special type of chain, instead of gearing, are used for feeding the timber through the machine. The springs are of sufficient strength to prevent the wood from rising. The table for carrying the timber can be raised or lowered as required, to suit the various conditions under which the machine will have to work. This is done by turning the hand-wheel shown on the left of the machine in the illustration. The table is fitted underneath with anti-friction rollers. A sheet metal-hinged hood is fitted over the sand-papering drums, thus enclosing them and preventing dust from flying around. The enclosed case is fitted with an outlet tube, which is in communication with a small fan for removing the dust, and deposits it in any convenient place. The main-frame is made all in one casting. The drive can either be by motor direct, with special pulley, or from a countershaft, as one belt serves to run the first and third sand-papering drums, also the revolving brush. Another belt is used for driving the second sander drum, from which shaft the fan is driven. A separate belt is required for the feed motion.

The panel-scraping machine, shown in Fig. 2, is solidly built, and embodies many improvements. The work as it is passed through the machine is operated upon by a thin steel blade having a turned-over edge, which removes a very fine shaving, and imparts a good and natural finish to the hard-wood panels. The knife is carried in a heavy metal box, arranged so that it can be drawn out. The work is fed by means of a feed gear, which consists of eight rollers—four at the top and four beneath—all driven by machine-cut gearing, over which a cover is placed. A new form of pressure device is provided, which comprises an india-rubber-covered roller supported on springs, and provided with a separate screw adjustment. The table is raised or lowered by a power friction feed. The machine is here arranged to be driven direct by motor, although it can, of course, be driven by other methods.

PROGRESS IN IRON AND IN MECHANICAL ART.*

By J. H. WICKSTEED.

(Concluded from page 578.)

THE time of Homer, 880 B.C., was notable for the attention that was given to iron. At that time it must have been cheaper than bronze, as is evidenced by the fact that objects have been dug from the mounds of Nineveh of about the time of Homer, and of which some consisted of cores of iron, round which bronze had been cast. In the wall sculptures from Nineveh in the British Museum, there is one in the Nimrûd Gallery illustrating the campaigns of Assur-nazir-pal, 884 B.C. It shows a battering-ram and a chain to catch up the head of the ram to destroy its action. The beam of the battering-ram is hinged near the centre, and it is swayed up and down from the light end by men behind the protection of a barricade. The chain is hung down in a loop from the walls of the besieged city to catch the heavy end and break its force as it descends against the wall.

The ram-head was almost certainly a bronze casting, and the chain in all probability of forged and welded iron, as the following evidence will show. For, on referring to other finds in the mound of Nimrûd, Dr. Percy writes:—"That the Assyrians were well acquainted with iron is clearly established by the explorations of Layard, who has enriched the collections of the British Museum with many objects of iron from Nineveh of the highest interest. Amongst these may be particularly specified tools employed for the most ordinary purposes, such as picks, hammers, knives, and saws. There is a saw similar in construction to that now used by carpenters for sawing large pieces of timber across. It consists of a blade 3ft. 8in. long and 4¾in. broad throughout its entire length, except at one end, where it is narrowed, and was no doubt let into a handle of wood, the rivets being visible upon it. It was found in the North-West Palace of Nimrûd, and could not be in date later than 880 B.C. The fact of iron having been applied to common hammer heads, for which bronze might have proved a tolerably good substitute, indicates that iron was certainly as cheap, if not cheaper, in those days than bronze, and the correctness of this inference is strikingly confirmed by many other objects from the same locality, consisting of cores of iron around which bronze has been cast."

And a few centuries later a chain for a similar purpose is specially described by Thucydides, who says that the Plateans, during the siege of their city by the Thebans—429 B.C.—made use of long iron chains to suspend beams which they dropped, so as to break off the heads of the battering-rams brought up against their city. At this same period iron was known to make such formidable instruments of war that, as is recounted by Pliny the Elder, in the treaty which Porsena granted to the Roman people on the expulsion of the Kings—509 B.C.—there was a specific provision that iron was not to be used except in agriculture, and the most ancient authorities have preserved the fact that it was then that writing with a bone style came into practice. A classical friend has sent me a passage from Pliny's "Natural History," Book 34, cap. 39, which is prophetic of the importance of iron, and which shows that at this period the uses of iron were restricted, and its progress a negative quantity:—"The first mines we should mention are those of iron; iron is the best and worst implement of life, inasmuch as therewith we cleave the earth, saw trees, prune bushes, compel our vines to renew their growth yearly by shearing off their growth, build houses, shape stones, and for all other purposes use iron; but we likewise use it for war, slaughters, robberies, not only at close quarters, but also as a swift missile, now hurled by engines, and now by the arm, and sometimes even winged, which latter I take to be the most infamous perversion of the human intellect, inasmuch as we manufacture this monstrous bird and give the iron wings that death may reach man the quicker. Wherefore the blame of man must not be set down to the account of nature."

Iron chains were used by the Romans. Besides the literary evidence of iron being used by them we are not without actual samples existing of iron chains made by this nation, and we can see their form.

The Saalburg, near Homburg, was built and inhabited as a Roman fortress between the years 11 B.C. and 274 A.D., and there is still preserved the iron chain with its hook which they used for elevating water from a well, also iron chains for horses. These iron chains are welded, and are beautifully made. The well chain is of a flat rectangular section and oblong, something like the Roman chain which is depicted in a mosaic pavement excavated from Pompeii, and inscribed "Cave Canem."

Pompeii was probably founded about 500 B.C., and was buried by lava in 79 A.D. The house was, therefore, built any time between these dates, and in the floor of the hall immediately behind the double front door was a dog attached to a chain, outlined in black and white mosaic, with the inscription, "Beware of the dog." These veritable examples of earlier iron chains are not of round section, but of rectangular section. This is accounted for by the fact that iron is more easily drawn down from a lump by hammering on an anvil into a flat or square rectangular section than into a round section. This is another reason why the Nimrûd chain may be considered to be iron. The sculpture does not show the links rounded, but flat.

Cæsar mentions that when he invaded Britain 55 B.C. the currency of the people consisted partly of iron rings adjusted to a certain weight. Thus, at the beginning of the Christian era both the Romans and the Britons had long understood the working of iron. The Romans, as has already been said, used mooring chains for their galleys. They fortified York, and to join the wall across the river they were very likely to place a chain.

This brings us near home. The Romans were established in Britain for more than 370 years, and during the space of three centuries and a-half they had possessed the country of the Brigantes, of which the present county of York was the principal part. During this long space of time they had completely Romanised the country, and made the same improvements as in the rest of their provinces. The Romans did not leave much to chance, and, in addition to the walls and towers with which they made York impregnable, it is probable that they stretched chains across the Ouse to prevent an enemy's entrance within the city by water. At any rate, chains were used for that purpose later on, as Leland, who wrote at the time of Henry the Eighth, mentions in the following graphic account:—"The towne of York standith by west and est of Ouse River running through it. Thus goeth the waul from the ripe Ouse of the est part of the cite of York. Fyrst a grete towre with a chain of yron to cast over the Ouse, then another towre, and so on to Bowdamgate. Betwixt the beginning of the first parts of this west waulles and Micklegate, be IX towres, and at this XI towres be a postern-gate, and the towre of it is right agayn the est towre, to draw over the chain of Ouse betwixt them."

Of the probable form of the chain here spoken of we have curious indirect evidence.

Upon the old Ouse Bridge there stood a chapel, dedicated to Archbishop William Fitzherbert—twelfth century. At the Reformation the chapel was converted into an Exchange for city merchants. Upon the decay of trade it was divided into a council chamber, a record-office, and a prison for the freemen of the city. The building was taken down in 1810. A portion of the arch in this chapel is preserved in the Hospitum at York. It shows a chain moulding, which is a form of ornament found in Norman arches, and strongly suggests the existence of such a chain in the vicinity for the sculptor to have imitated. May it not probably represent such a chain as the Romans stretched across the river in the early centuries of the Christian era? The links are still of rectangular section, but are oval. From such a chain as this at York we can find no improvement till iron began to be rolled.

In the oldest chapel cloister of the burial-ground of Pisa there hang upon the walls the chains of the ancient harbour of Pisa, captured by the Genoese in 1632. They are very much like more modern mooring chains. The Cathedral of Pisa was erected after the great naval victory of the Pisans near Palermo, 1063, and it is probable that similar chains guarded their harbour at that time.

It has been remarked before, when looking at the mediæval chain ornament at York, that we can find no essential improvement in the form of link till within the last hundred years, but the old patterns overlap the new, and a photograph was shown of the chain cable of a Russian line-of-battleship sunk at Sevastopol by the Russians after the battle of Alma, and presented to the Leeds Museum by Mr. Henry Dixon. The links are remarkably similar to the Pisan Harbour chain, only the section of iron in the older chain is rectangular, being forged out entirely by the hammer, whereas the section of the Russian chain is round, indicating the use of grooved rolls to prepare the round bars of which the links were made.

It was in 1874 that Henry Cort invented the process of puddling iron and rolling it into rods with grooved rolls. These inventions opened the way for making chain cables with links of uniform section and quality. There had long been a craving for chain cables to take the place of hemp hawsers on ships. Sir Cloudesley Shovel recommended them in about the year 1700, and previously—viz., in 1634—a patent was obtained by an Englishman of the name of Phillip White, blacksmith, for "a way for the mearing of shipps with iron chaynes by finding out the true heating, p'paring, and temp'ing of iron for that purpose; and that he hath now attayned to the true use of the said chaynes, and that the same will be for the great saveing of cordage and safety of shipps, and will redound to the good of our co'mon wealth."

No further mention of the use of chain, either as moorings or cables, is made until so far forward as the year 1804. By that time rolled bars of puddled iron were available, and a patent was enrolled by one John Slater, a surgeon, of Huddersfield, in the County of York, "for a new and improved method of manufacturing and fabricating of cables, shrouds, stays, and other articles for the rigging of ships of materials never before used for that purpose." No result came of the invention, and the field was still left open for the practical and positive introduction of cables made of chain for the use of the naval and mercantile marine of the world.

This took place in 1808, when Robert Flinn, an Irish blacksmith, whose father fought under General Wolfe, who fell in the elder Flinn's arms, made iron chain cables at his forge in North Shields, which were used in the vessel called the Ann and Isabella, built at Berwick-on-Tweed, and in the same year Lieutenant Samuel Brown, of the Royal Navy, fitted out a vessel called the Penelope with her entire rigging of chain and with chain for her cables.

Up to this time chain was only known to be made by welding on the ends, and in 1811 many chain cables parted. This led to welding the links on the side when made of iron more than 1in. in diameter, with a long scarf, which gave the men room and iron to work upon. Also it led to the adoption of the stud to keep the links from collapsing, and so to preserve the freedom of the joints, and consequently the cable's flexibility.

In 1816 Brown's second patent was first made. Previous to that date studs were unknown. It is elliptical, which gives a curve of the same radius as the iron of which the links are made at the inside ends of the links, so that the links bed on each other, with surfaces which coincide, while the enlarging radius of the ellipse allows clearance sideways to give flexibility to the chain. The weld is about ·8 of the strength of the bar, and the breaking strength of the chain is about 1·5 of the strength of the bar. But before the breaking strength of an unstudded chain is reached, the links become deformed and locked, and the flexibility of the chain is gone. It may therefore be fairly argued that the weld does not take away from the useful strength of a chain

* Institution of Civil Engineers: Association of Yorkshire Students. Lecture delivered at Leeds, November 16th, 1905.

but its disadvantage is that it necessitates the chain being made of iron soft enough to be capable of welding. If, therefore, it be possible to make chain with interlaced links without welding, then very strong hard steel could be used, and the chain of the future could be made of double the strength, weight for weight, of the present-day chain. At first glance it might seem difficult to form interlaced links out of a solid bar, but many a collier in his leisure hours has performed the feat of cutting a wooden chain out of a besom tail.

But if it be possible to form a wooden chain with solid links it is also possible to form it of hard steel.

A lantern slide of a chain of which 200 yards are in work at the West Riding Colliery, Normanton, was shown. It is the best piece of chain which they have on the colliery.

It will be noticed that there are studs, and the ends of the links are made with a deeper section than the sides so as to allow for wear. Add to this that it is made of steel. It is an ideal chain, and has twice the strength and twice the wear of a chain made from welded iron rods.

Another slide showed the first stage of the process by which it is made. The openings in the links were punched out cold from a bar of cruciform section. The process is too expensive and too wasteful of material to be continued, but it is an ideal chain. Renewed efforts are now being made to produce this ideal chain with commercial success.

An illustration was given of a method of rolling it hot till it is nearly formed, and shows it at a further stage, when the thin films remaining from the rolling have been punched out; but along the centre of the chain bar there still runs a solid rod, which has to be cut out with shaping tools to separate the links; after this the links are heated and squeesed oval.

Another slide presented a view of a rolled weldless chain bar after the thin films have been punched out, and before the solid rod running along the centre has been cut out and the links separated and bent into their finished oval form.

If a weldless chain of strong steel—and for some purposes case-hardened—comes into use in the present century, it will bring about an improvement of 2 to 1 upon the chain that has prevailed for a hundred years—that is to say, it will double the strength, weight for weight. Its development arises from an improvement in mechanical art concurrently with the improved production of steel.

Now, we have seen that we cannot trace back the existence of iron chains beyond 3000 years ago, yet iron itself must have been known and used in Egypt 6000 years ago. It seems, therefore, to have taken 3000 years with the knowledge of iron to make a beginning with iron chains; then, with improvements over a period of 3000 years they attained an efficiency which we will take as the primary unit. Then, in the nineteenth century, the beautiful round-section, oval-shaped, short-link chain was invented, and with the improvements in the quality of the iron and the perfection of manufacture which has been going on all through the century, and which, it may be incidentally remarked, has largely been brought about by the use of testing machines, it is safe to say, has improved the chain equal to nine added units of efficiency upon the previous square-cornered self-destructive chain; and now, during the twentieth century, if we double the efficiency of the nineteenth-century chain, weight for weight, we shall have even more than kept up the nineteenth century rate of improvement, because we shall have added another ten units of efficiency during the century, while the nineteenth century added nine units to the primary efficiency unit of the Roman chain.

The writer has thus attempted to bring home to all our minds the rate of improvement which is taking place in the domain of iron and mechanical art. We need not regret that none of us were born at the dawn of the machinery era, because there is as great scope now as then for our activities in doing our part to better former practice, and there is as great a reward for us in doubling the efficiency of iron and machinery on nineteenth century practice as there was for the engineers of the nineteenth century when they multiplied by ten the efficiencies of the previous ages.

This, gentlemen, concludes the thesis with which this address was started, viz., that if the inventions developed in 100 years multiply the efficiency of human effort nine or tenfold, you have only to multiply the efficiency of such inventions twofold to achieve an improvement which adds as many units of efficiency to human effort as was effected by the previous developments, because if the original inventions added nine or ten units of efficiency, a 2 to 1 improvement will add a like number, and will give an arithmetical progression of efficiency for the two successive centuries. From this point of view we find that the rate of progress in iron and mechanical art in which we are at the present time participating is, to all appearance, continuing to be as rapid as was the marvellous rate which was started by all the brilliant inventions of the nineteenth century.

THE INSTITUTION OF CIVIL ENGINEERS.

PASS LIST, OCTOBER EXAMINATIONS, 1905.

Studentship (54).—V. B. Atkinson, J. P. R. T. B. Bacon-Phillips, F. Bates, G. T. Baxter, H. I. Becker, A. G. W. Bicknell, R. Blackburn, E. R. Branston, G. D. Brockman, T. S. Butler, C. P. Cole, F. L. Cook, J. C. Cooper, T. H. Davies, C. H. Delgado, J. Douglas, F. G. Engholm, J. Ferguson, V. Field, D. C. Fletcher, F. W. C. Fowle, W. Fyffe, D. W. Gollan, W. H. Gorton, R. J. Grant, K. D. D. Grazebrook, R. F. Hall, A. R. Hannaford, P. Harrison, A. J. Hillman, A. M. Hutchinson, G. H. Hutchinson, H. L. Jackman, G. S. Jones, F. C. P. Lawrence, F. W. Littlewood, H. J. McLaren, C. E. May, F. L. Morton, E. F. O'Brien, W. D. Pile, J. E. Pullen, R. Ratcliffe, H. C. Rice, L. R. Ronald, N. W. Sayer, G. O. Sharpe, D. E. Smith, V. G. H. Smith, S. P. Thompson, A. E. Wheatley, G. S. Wilson, E. G. Woodward, A. H. Wright.

Associate Membership (129): *Whole examination* (74).—L. W. Atcherley, R. J. S. Bateman, R. S. Bayntun, W. Burn, W. H. Carson, F. T. Chapman, R. H. Collingham, W. W. Coster, D. D. Daruvala, W. R. Davidge, J. A. Davidson, I. P. Davies, W. M. Duguid, J. Eastwood, V. Elkington, M. Elliott-Cooper, D. Ellison, J. R. F. Fitzherbert, R. A. Frank, A. McN. Fulton, C. T. Gardner, L. T. Grace, J. M. Granger, J. U. R. Grave, J. A. Hardie, A. F. L. H. Harrison, F. M. Harvey, J. B. Harvey, W. F. Hole, E. E. F. Homer, W. J. A. E. Horne, F. W. R. Hurt, H. F. Hutchinson, J. H. Inglis, J. F. Izat, L. C. Lambert, K. Lightfoot, W. Longland, A. McClure, G. D. McGlashan, E. D. McQueen, L. J. Marriott, G. S. Marsh, F. O. Medworth, R. F. Middleton, H. E. Midgley, E. Minors, L. Morgan, W. T. Nash, A. K. Nixon, G. C. Onslow, A. E. Paul, G. R. de Peyrecave, F. G. A. Pinckney, A. O. W. D. Pinson, P. F. P. Plomer, J. G. Pring, A. B. Radford, A. T. Roberts, F. W. C. Roberts, A. Rogers, G. P. Ross, H. G. Rowley, M. A. F. Saleit, A. C. Smith, C. H. Sumner, F. Turner, J. A. Varey, W. H. Watney, H. G. Watson, J. A. Watts, E. G. Weeks, A. F. J. Wright, H. E. Yarrow.

Section B of Part II. (18): (*previously passed in Part I. and Section A of Part II.*)—E. W. Ball, W. A. Brown, W. H. M. Finch, J. F. Frew, A. M. D. Gallini, F. B. Gibbard, F. J. W. Maddox, W. T. W. Miller, H. E. Morrall, J. Owen, S. R. Perfect, D. L. Serpell, R. W. Thomas, J. C. L. Verley, C. W. Wales, H. S. Watson, A. While, A. C. E. Willink.

Part I. and Section A. of Part II. (37).—R. N. Aylward, G. N. Baines, N. W. Bancroft, A. Barlow, H. M. K. Berridge, J. F. Blackwood, H. S. Brailsford, F. H. Clough, C. G. Cotton, B. C. Covell, J. F. Croadsdell, H. F. D. DeCourcy, K. Fisher, C. D. Gee, W. W. R. Harlow, C. W. Harris, C. H. Hutchinson, J. A. Hutchinson, I. J. Jones, T. Jones, E. R. Matthews, A. C. Medlock, A. C. Mitchell, jun., R. E. H. Orrinsmith, J. D. Rennie, B. Reynolds, C. T. Richardson, H. C. Ritchie, H. I. Robinson, T. M. Scully, C. W. Sheppard, J. H. W. Smith, A. D. Spooner, H. J. H. Stevens, H. C. Swayne, P. M. Tremlett, G. H. Whitehouse.

SOCIETY OF ENGINEERS.

THE fifty-first annual general meeting of the Society of Engineers was held on Monday, December 11th, 1905, at the offices of the Society, 17, Victoria-street, Westminster.

The chair was occupied by Mr. Nicholas J. West, president. The following gentlemen were duly elected by ballot as the council and officers for 1906, viz.:—As president, Mr. Maurice Wilson; as vice-presidents, Messrs. Richard St. George Moore, Joseph William Wilson, and William Henry Holttum; as ordinary members of council, Messrs. John Aird, Joseph Bernays, Alexander Graham Drury, George Abraham Goodwin, George Green, Edward John Silcock, Diogo Andrew Symons, and Francis George Bloyd; as honorary secretary and treasurer, Mr. David Butler Butler; as honorary auditor, Mr. Samuel Wood, F.C.A.

The President announced that the Right Hon. Lord Rayleigh, F.R.S., O.M., Chairman of the National Physical Laboratory, and Sir Alexander Richardson Binnie, President of the Institution of Civil Engineers, had been elected by the Council as honorary members of the Society, thus filling the vacancies created in the list of honorary members by the deaths of Sir Lowthian Bell, F.R.S., and Mr. James Mansergh, Past-president of the Institution of Civil Engineers.

The President announced that the following premiums had been awarded by the Council for papers read during the past session, viz.:—The President's gold medal to Mr. Sherard Cowper-Coles for his paper on "The Metallic Preservation and Ornamentation of Iron and Steel Surfaces"; the Bessemer premium of books to Mr. Ernest Romney Matthews for his paper on "The Parade Extension Works at Bridlington"; a Society's premium of books to Mr. Benjamin Laurenson Bradley for his paper on "The Grindleford Stone Quarries and their Working;" and a Society's premium of books to Mr. William Pollard Digby for his paper on "Statistics of British and American Rolling Stock."

A vote of thanks was accorded to the Scrutineers, and the proceedings terminated by a vote of thanks to the President, Council, and officers for 1905, which was duly acknowledged.

On Wednesday evening the Society held its annual dinner at the Hotel Cecil. The gathering was not as large as last year, which saw the jubilee of the Society, but the evening was very enjoyable, and the dinner — Mr. Nursey's particular care — excellent.

LAUNCHES AND TRIAL TRIPS.

ISLE OF WIGHT, steam fleeter; built by Earle's Shipbuilding and Engineering Company, Limited; to the order of Hull Steam Fishing and Ice Company, Limited; dimensions, 108ft. 4in. by 21ft. 6in. by 11ft. 6in.; engines, triple-expansion, 10in., 17in., 28in. by 22in., pressure 185 lb.; launch, December 2nd.

VELASQUEZ, large liner; built by Sir Raylton Dixon and Co., Limited; to the order of Messrs. Lamport and Holt; dimensions, 481ft. by 51ft. by 40ft. 8in.; to carry 11,000 tons deadweight; engines, triple-expansion, 27in., 46in. and 79in. by 60in., pressure 200 lb.; constructed by Richardsons, Westgarth and Co.; launch, December 9th.

TAARNHOLM, single-deck type steamer; built by Wood, Skinner and Co., Limited; to the order of Copenhagen owners; engines, triple-expansion, 19in., 31in., 51in. by 33in., pressure 180 lb.; constructed by North-Eastern Marine Engineering Company; the machinery worked without a hitch; trial trip, December 9th.

SINGLE turret steamer; built by Wm. Doxford and Sons, Limited; to the order of the Red "R" Steamship Company, Limited, Newcastle; dimensions, 350ft., 51ft. by 28½ft.; to carry 6800 tons; constructed by builders; launch, December 12th.

SIEGLINDE, steel screw passenger and cargo steamer; built by Irvine's Shipbuilding and Dry Docks Company; to the order of a Hamburg firm; dimensions, 332ft., 45ft. by 24ft. 9in.; engines, triple-expansion, 23½in., 38in., 64in. by 42in., pressure 180 lb.; constructed by Richardsons, Westgarth and Co., Limited; launch, December 12th.

ALMANACS, CALENDARS, &c.

AN early batch of these acceptable annual publications includes a wall calendar with tear-off monthly slips, and a combined blotting-pad and calendar from the Sun Fire Office, a desk calendar with monthly cards from Messrs. W. Summerscales and Sons, Limited, Keighley, and a very effective wall calendar with dates in large type from Messrs. George Cradock and Co., Wakefield. The last has a sporting picture in colours showing a pack of foxhounds in "full cry." The plate is admirably printed. Messrs. John Rogerson and Co., of Wolsingham, Durham, are issuing a wall calendar with views of their works and details of manufacture. The wall calendar for 1906 sent us by the United States Metallic Packing Company, Limited, Bradford, shows the good taste which this company has previously led us to expect in these productions. The pictorial portion represents a female figure, "Progress," in bas-relief. The calendar is of the monthly tear-off pattern, in clear black and white.

THE INSTITUTE OF SANITARY ENGINEERS.—On Wednesday evening a number of members and guests met at the Holborn Restaurant for the annual dinner of the Institute of Sanitary Engineers. In the enforced absence of the President, Mr. Crowther, Professor Coker, president-elect, was in the chair. An excellent musical programme had been arranged, and a very pleasant evening was passed.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The second general meeting of the session will be held in the Lecture Hall of the Literary and Philosophical Society, Westgate-road, Newcastle-upon-Tyne, this evening, Friday, December 15th, 1905, at 7.30 p.m. The discussion on Mr. Schofield's paper on "Pneumatic Tools as Applied to Ship Construction" will be resumed, and a paper on "The Engineering Value of Lubricating Oils," by Mr. W. F. Parish, jun., will be read and discussed. The third general meeting of the session will be held on January 19th, 1906. Paper on "Commercial Dry Docks," by Mr. J. M. Moncrieff.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—On Monday, 11th inst., through the courtesy of Mr. Vincent Hill, the general manager, and Mr. P. C. Tempest, M. Inst. C.E., the chief engineer of the South-Eastern and Chatham Railway, a party of members of the above Society, accompanied by Mr. W. B. Esson, M. Inst. C.E., the president, and Mr. A. S. E. Ackermann, B.Sc. (Eng.), the hon. secretary, was enabled to visit the scene of the recent disaster at Charing Cross. The members of the Society appeared fully to appreciate the spirit in which the authorities had met their request, and made good use of the opportunity of examining the broken structure. Unfortunately, the dense fog prevailing at the time made it impossible to see as much as was hoped; in fact, at one time the roof was completely lost to view, but on the platforms and permanent way the devastation caused by the falling girders was almost indescribable, and it must be a very long time before the heaps of *débris* can be cleared away. It was noticed that though the woodwork of some of the carriages was practically pulverised, not one of the axles was broken, and the frames seemed hardly damaged. The members were able to inspect the Avenue Theatre also, through the courtesy of the architect, Mr. Detmar Blow, and were carefully shown round by the builder's foreman. Here, too, the havoc was complete—scaffold poles, roofing materials, and planks having been carried into the body of the theatre by blocks of brickwork from the station wall weighing several tons each, so as to form two funnel-shaped masses.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

ACTIVITY characterises the engineering establishments in most branches. There is plenty of work to go on with, and engineers can see their way well into the New Year. Cheerfulness, therefore, is the prevailing feeling, and although the break in work which the Christmas holidays afford will, as usual, be welcomed, the stoppage of the engines and machinery on that account will probably be shorter than for several years past.

In the pig iron trade stocks in consumers' hands are low, and although the output has recently been enlarged, yet the supply is by no means in excess of the demand; indeed, in some instances, it does not come up to that level. In some branches consumers appear, however, for the present, to have satisfied their requirements, but even where this is the case, quotations are well upheld. About 55s. is asked for Staffordshire cinder forge; with part-mines 60s. to 62s. 6d.; ordinary all-mines being 65s., and best 87s. 6d. to 90s. The inquiry for cold blast is somewhat slow at 105s. Derbyshire pig iron is quoted 58s. to 60s.; with 57s. 6d. to 60s. for Northampton.

Manufactured iron is in somewhat less inquiry this week, as is usual towards Christmas, but this does not weaken quotations; indeed, current figures are above those of a fortnight ago, the reason assigned being the extra cost of raw materials. Marked bars are still quoted £8 10s., but the Unmarked Bar Association have recently put up prices another 5s., making the official quotation £7. Gas strip has also been advanced 5s., making the new quotation £7 to £7 2s. 6d., and a similar rise has been declared in hoops, which are now quoted £7 15s. Steel strip is also quoted £7 15s., this being 5s. more than previously. Galvanised corrugated sheets form one of the best departments of the market, there being a sustained foreign and colonial inquiry. Last month's exports reached over 38,000 tons, or 2000 tons more than in the corresponding month of last year, the value being over £460,000.

With regard to the eleven months' business in this class of iron, this reached, broadly, 371,000 tons, or nearly 23,000 tons more than last year, the value being over £4,000,000. India was the chief market—including Straits Settlements and Ceylon—with 64,000 tons, which, however, was less than a year ago. The Argentine Republic took second place with 60,000 tons, or some 15,000 tons better than last year. The third place is occupied by Australia with 49,000 tons, which, however, is less than last year. There have been numerous cases of improvement, including a notable increase with Japan from 12,000 tons to 23,000 tons, or nearly double; whilst a larger business than a year ago, it is pleasing to be able to record, has been done with Portuguese East Africa, the West Indies, Chili, Mexico, New Zealand, and Canada. Galvanised corrugated sheets of 24 gauge are quoted this week £12 to £12 5s., f.o.b. Liverpool.

Steel is in good inquiry, alike as regards semi-finished sorts and engineering sections. Bessemer billets are £5 to £5 5s., with Siemens about the same. £7 5s. to £7 10s. is required for mild steel bars. Girder plates are in good demand at £7 10s. to £7 15s., and boiler plates move freely at £8 10s. to £8 15s. Structural engineers are taking joists at £7 to £7 5s., and angles at £6 15s. to £7. Angles, plates, channels, and some other descriptions are needed freely by the makers of railway rolling stock.

Contracts of an hydraulic engineering character may be expected before long from Shrewsbury. At a recent meeting of the Shrewsbury Town Council a further report on the Castle Pulverbatch upland water scheme for supplying the borough was presented by the Water Committee. This showed that the cost of acquiring the watershed would probably be £35,000. Towards this there would be a direct income sufficient to pay interest on £20,000, and as £5000 for land and leasements was included in the engineer's original estimate of £148,000, the sum to be added to this, if the watershed is acquired, will only be £10,000. The Committee showed that the watershed would give a 200 days' supply, and they also give an analysis of the water, made by Dr. Bostock Hill, which was regarded as satisfactory. The Council resolved to proceed with the Castle Pulverbatch scheme, and to authorise the Committee to take steps for the preparation and promotion of a Bill in Parliament for carrying out the same.

A water supply undertaking of considerable importance has been decided upon at Wolverhampton. The Town Council have adopted a report in which the Water Committee state that in order to increase the volume of water to be obtained for the use of the people in the district, a bore-hole has been made at Tettenhall, and a large volume of water of excellent quality has been found. The Committee recommend that another reservoir be constructed at Tettenhall, that additional mains be laid down, and that two more boreholes be sunk. The cost of the new undertaking is estimated to reach £75,000.

In connection with what is known as the Brewood sewerage scheme, the chairman of Cannock Rural District Council has, during the week, formally declared the outfall works open. The design is on the bacteriological system of sewage disposal, and the works are intended to deal with 24,000 gallons per day. Arrangements are also made to deal with 24,000 gallons of overflow. The scheme has been formulated and carried out by the engineer of the Cannock Rural District Council, Mr. H. M. Whitehead. The cost of the works will be £1550, or £100 less than the engineer's estimate.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—There is a distinct falling off in the buying of pig iron in this centre, which can be readily understood, seeing that the end of the year is rapidly approaching, when stocktaking and other important matters are on hand. In other respects, engineers and ironfounders are very busy, and in view of rapidly diminishing stocks of crude iron, they should be soon in the market again for renewals. The condition of affairs in Russia, and the prospect of a general election in January are, however, matters to be considered, and it can be well understood that many firms of machinists having a connection with Russia, are already suffering from an absence of orders from that country. This is very noticeable in certain departments of machine fittings for looms and spinning frames, but no doubt many others are adversely affected, though not to the same extent.

The attendance on the Iron 'Change continues good on both market days, but there is a noteworthy absence of makers and makers' representatives, who have little or no pig iron to offer for prompt delivery. There is a fair quantity of Scotch iron being absorbed, and some Cleveland is being placed in the Manchester district. There is no change to note in Lincolnshire, Staffordshire, or Derbyshire. In forge iron heavy deliveries are reported against contracts, and there is some buying going on. Makers, however, adhere to full rates for new business, which leads to increased firmness in the finished article. Indeed, it was rumoured on 'Change on Tuesday that a meeting of bar and hoop makers had been held, with a view to an advance, but inquiry showed this was not the case, although it is not improbable that an advance may be made in the near future. Pig iron quotations are:—Lincolnshire No. 3 foundry, 59s.; Derbysbire, 61s. to 61s. 6d.; Staffordshire, 60s.; Middlesbrough, open brands, 62s. 4d.; West Coast hematite, 79s. 6d.; East Coast ditto, 79s. 6d. net. Scotch: Gartsherrie, 68s. 3d. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 65s.; Dalmellington, 64s. 6d., delivered Manchester. Delivery Heysham: Gartsherrie, 67s. to 67s. 3d.; Glengarnock, 62s. 9d.; Eglinton, 62s. 6d.; Dalmellington, 62s. Delivery Preston: Gartsherrie, 67s. 3d. to 67s. 9d.; Glengarnock, 65s.; Eglinton, 64s. 6d.; Dalmellington, 63s. 6d.

Finished iron quietly steady. Bars, £7 to £7 5s.; hoops, £7 10s.; sheets, £8 10s. to £8 15s.

The "boom" in steel and steel products continues. Billets, both English and foreign, are very firm, and orders for sheets are only accepted at a premium on official rates. Bars quoted £7 5s. to £7 10s.; hoops, £7 15s.; boiler plates, £8 2s. 6d. to £8 5s.; plates for tank, girder, and bridge work, £7 15s. to £8; English billets, £5 5s. to £5 12s. 6d.; foreign, £5; sheets, £8 15s. to £8 17s. 6d.

The smart advances in raw copper have created something of a sensation here, and corresponding advances have had to be made in the manufactured article. All classes are dearer, sheets £4 to £6 per ton, and tubes, including brass, also ¼d. per lb., making about 1d. per lb. on the past three weeks or so. Sheets quoted £94 to £96 per ton; seamless copper tubes, 11¼d. to 11¼d.; brazed, 11¼d.; brass tubes, 9¼d.; condenser, 10¼d.; brass wire, 8¾d.; rolled brass, 8¼d.; brass sheets, 9¼d. per lb.

Sheet lead unaltered at £19 5s. per ton.

In coal there is little change to note, but the demand for manufacturing coal and slack is well maintained at full rates. Best coal, for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s.; steam and forge coal, best, 8s. 3d. to 8s. 9d.; best engine fuel, 7s. 9d. to 8s. 6d.; best slack, 7s. to 7s. 6d.; medium, 6s. to 6s. 9d.; common, 5s. to 5s. 9d. at the pit. Screened coal, 9s. 9d. to 10s.; unscreened, 9s. 3d. to 9s. 6d., delivered Manchester Ship Canal.

Arising out of Prof. Nicolson's paper on the training of engineers, a meeting of the Engineering and Metal Section of the Manchester Chamber of Commerce was held in this city on Monday, to which the members of the Engineers' Association were invited. Mr. W. T. Stubbs presided. The object aimed at is, "the selection by employers in this neighbourhood of a small percentage of their young workpeople"—of such as have shown special ability and perseverance in the early part of their apprenticeship—"to receive the privilege of two sessions of study at the Municipal School of Technology. The intention is to provide for the district a small supply of men as highly trained in theoretical and experimental work as those produced in the foreign technical high schools, whilst at the same time retaining the thorough practical training afforded to the English apprentice which the foreigner lacks." A letter was read from an English engineer in Germany, which deprecated the highly technical aspect of the apprenticeship method, and cautioned Englishmen against too great extension of technical schools as compared with actual practice. The meeting seemed rather to endorse this view.

Barrow.—There is a stronger demand for hematite iron this week, and, as a consequence, prices have advanced. Mixed Bessemer numbers are now at 71s. 6d. net f.o.b., and warrant iron is at 71s. 6d. net cash sellers, buyers 3d. less. The prospect is that prices will further improve, and the opinion of those best capable of forming a judgment on the position is that 75s. will be reached early in the new year. This forecast is arrived at because, first, of the fact that it will not be possible to increase the output of pig iron much further, and, secondly, because the known requirements of consumers in the new year will be larger than they are now. Very little of the iron now being manufactured is being used in the Bessemer trade, but if the latter should soon be busy again there will be a scarcity of hematite iron. Stocks have been increased again this week, and now stand at 47,363 tons. Some good orders are to hand for spiegeleisen, ferro-manganese, and charcoal iron, but a quiet trade is being done in forge and foundry iron.

Iron ore is in brisk demand, and there is more activity at iron mines in the district than for a considerable time past. Prices are steady at 15s. per ton net at mines. Best sorts are at 19s. and 19s. 6d. per ton, and the latter are also the quotations for good classes of foreign ore at West Coast ports.

The steel trade is busy on shipbuilding material. Orders are well held, and are being liberally offered. The chances are that the business in mild steel in the new year will be considerable. Prices are at £7 for ship plates. There is still a quiet demand for steel rails, and the rail mills at Barrow have again been employed on a small rail order or two, and in the production of billets and tin bars, for which there is a moderate demand. Very little is being done in merchant steel, but overtime is being worked at the British Griffin Works on chilled castings.

Shipbuilders have booked no new orders. Messrs. Vickers, Sons, and Maxim are busy pushing forward the completion of the Japanese battleship Katori, and are also actively at work on the first-class Russian cruiser Rurik, on two cruisers for Peru, and on about twenty submarines for the British Navy.

Engineers are very busy on submarines, gun mountings, and projectiles.

Shipping is quieter this week. Exports from West Coast ports last week were:—Pig iron, 1535 tons; steel, 7529 tons; total, 9064 tons; decrease on the corresponding week of last year, 19,203 tons. The aggregate shipments this year have reached 775,707 tons, being an increase on the corresponding period of last year of 70,079 tons. Freights are firmer.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE coal trade in South Yorkshire and adjoining localities continues firm in nearly all qualities. Household fuel, in spite of the exceptionally mild weather, is in good request for London and Southern, as well as Eastern Counties markets, and the local business is quite up to the average at this season of the year. Best Silkstone, in which there is not a great deal doing, is at 12s. 6d. to 13s. per ton; Barnsley house, from 10s. 6d. to 11s. per ton at the pits; other sorts ranging from 9s. 6d. to 10s. per ton. Good slacks are freely ordered, but common slacks are difficult to clear. Coking slack and smudge are easily saleable at 4s. 6d. to 4s. 9d., and the demand, heavy as it is, will be increased very soon through the large number of by-product ovens now being erected.

The principal feature in the steam coal trade concerns the railway contracts expiring at the end of this month. These still remain unsettled, the railway companies are standing stiffly by their original resolution to give no more than last year's prices, and the South Yorkshire coalowners are equally decided in their demand for an advance of 6d. per ton. So far as South Yorkshire collieries are concerned, the situation remains as previously reported, with no prospect, judging from existing circumstances, of any immediate arrangement on a definite basis.

Gas coal continues to be in heavy demand, and deliveries under contract are very large. Sales in the open market show slight advances on contract rates. The make of coke is still increasing, and at present is somewhat in excess of market requirements. Durham coke, however, maintains its full rates, and local coke is, consequently, more freely used in smelting operations. Unwashed smelting coke of good ordinary quality is quoted at 11s. 6d. per ton, washed samples selling at 12s. 6d. to 13s. per ton at the ovens.

The trade done by South and West Yorkshire and neighbouring coalfields with Hull during November presents no striking contrast to that for the corresponding month of last year. The total weight taken to Hull was 331,600 tons, which figures show an advance of rather over 26,000 tons on November of 1904. For the eleven months the total weight is 3,457,616 tons, as compared with 3,271,648 tons for the eleven months of last year, an increase of close upon 186,000 tons. Two new pits—the Dinnington and Trickley—were amongst the contributing collieries last month.

The weight of coal exported from Hull last month showed a reduction of 3395 tons on the corresponding month of 1904, the respective weights having been 141,277 tons and 144,672 tons. The business done during the eleven months, however, exhibits an improvement, the weight for the completed period of this year, 1,549,415 tons, comparing with 1,470,908 tons for the similar period of 1904. Sweden heads the list with 29,489 tons, Russia is second with 20,970 tons, and Germany third with 18,115 tons. All these weights show a considerable decrease as compared with November of last year. For the eleven months Sweden took a weight of 311,772 tons, against 413,650 tons for the similar period of 1904; North Russia, 354,722 tons, against 341,038 tons; Germany, 182,218 tons, against 182,275 tons. Amongst the principal increasing markets are South America and Egypt, the former last month taking 12,287 tons, against 2383 tons for November of 1904; the latter, 11,070 tons, against 1803 tons. In the last eleven months South Amertca received 106,917 tons, against 75,170 tons, and Egypt 70,882 tons, against 44,637 tons.

In the iron market recent quotations are firmly maintained, and hematites are again somewhat higher, with every prospect of the rates being maintained to the close of the year. West Coast hematites are now at 82s. per ton; East Coast at 80s., both less 2½ per cent. Lincolnshire and Derbyshire irons are also firm. Lincolnshire No. 3 foundry, 56s. per ton; Lincolnshire No. 4, 54s. per ton; Lincolnshire No. 4 forge, 53s. 6d. per ton; mottled and white, 55s. 6d. per ton; basic, 55s. 6d. per ton; Derbyshire forge, 51s. to 52s. per ton; Derbyshire foundry, 56s. to 57s. per ton.

The military, marine, and railway material departments are as last reported.

There is a gratifying accession of orders in the file and edge tool trades, both on distant and home demand. Several foreign markets have recently yielded excellent work, and in certain specialities the departments are very busily employed. For saw files the requirements made upon one or two leading firms are exceptional. The heavier sizes of files generally are more in request than others. Chisels, plane knives, and similar goods are freely ordered. Taken all round, the various works are better employed than they have been for some time, and the prospects for the New Year are looked upon with confidence.

The foreign trade in cutlery for November amounted to £62,978, as compared with £58,042 for the corresponding month of last year. For the completed period of the year, however, the business exhibits a decrease, the value—£609,064—comparing with £631,683 for the eleven months of 1904. The increasing markets last year were Russia, Germany, Belgium, France, the United States, Chili, Argentine Republic, British South Africa, and British East Indies. Decreases were shown by Sweden, Norway, Netherlands, Spain and Canaries, Foreign West Indies, Brazil, Australia, New Zealand, and Canada. Although the business done with British South Africa during November—£3810—is £3113 more than was done in November of 1904, the value for the eleven months—£49,550—is £6124 less than for the similar period of last year. The improvement in the South African trade has only been during the latter half of the year.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE dullest period of the year, so far as regards the deliveries of pig iron, has now been entered upon, and business in Cleveland pig is rather slow, but not so bad as might have been expected. Traders look forward to a very active demand in the spring, both on home and export account, and there is reason to believe that higher prices will rule. What has hitherto kept ordinary Cleveland iron from advancing as quickly and as consistently as hematite, is that there is so much stock, and that this is every day increasing. Makers keep up their production, they sell all they can, and mostly send the surplus into the public stores; then they sell the warrants. For more than a year it has been expected that a large demand for Cleveland iron for American consumption would spring up, but so far consumers there have been able to do without it—they have augmented their production as fast as the consumption has increased—and what has been taken from this district this year, about 50,000 tons, have been nearly all hematite and spiegel, and more of the latter will be sent early next year.

The quotation for No. 3 Cleveland G.M.B. pig iron for prompt f.o.b. delivery has this week varied between 53s. 3d. and 53s. 6d. per ton, and 54s. for delivery over the first quarter of 1906. Makers have not come below 53s. 6d. for prompt, and anything under that appears to have been asked by second hands, who are able to supply warrant iron. The existence of the large stock has kept the price of Cleveland iron from advancing at the same rate as hematite iron, and also from rising so steadily. There have been many relapses in the upward movement of Cleveland iron prices, but not one in that of hematite rates. No. 4 foundry is at 52s., No. 4 forge at 51s. 3d., mottled at 50s. 9d., and white at 50s. 6d. per ton, all for early delivery.

The hematite pig iron trade in this district continues strong and active; in fact, the demand is almost too good, for it is larger than the producers can well satisfy with the present output, and they do not readily see their way to increase it, because of the difficulty of getting adequate supplies of materials at reasonable prices. The Spanish mineowners have substantially advanced their prices for Rubio ore, and are determined to reap their full share, and even more, of the improvement that is in progress in the steel trade here, and, consequently, in the hematite iron trade. They have raised the f.o.b. price for Rubio ore at Bilbao to 14s., and 14s. 6d. in some cases, against 10s. in the early part of the year. Merchants, therefore, can no longer offer to sell at 18s. 9d. to 19s. per ton c.i.f., seeing that the freight is 5s. 7½d. Bilbao to Tees, and this week they have put the delivered price of Rubio ore up to 20s. per ton, and in some cases to 21s., and even that does not leave them much to cover the risks, for they have to take the risk of the ore not reaching the 50 per cent. start, 6d. per unit being deducted by the ironmaster where the percentage of metallic iron falls below this, which cannot be recovered from the Spanish mineowner, for he will not give any specific guarantee in this respect, whereas the ore merchant here has to do so. In the spring 15s. per ton was the regular price for Spanish Rubio ore.

The better demand for East Coast hematite pig iron has this week led to the makers, who have been quoting 70s. for mixed numbers since early in October, advancing their price to 70s. 6d. for prompt, 71s. 6d. for next quarter, and 72s. 6d. for the second quarter of 1906, and these prices have been paid. What has partly helped to the advance was a report that was put in circulation that some of the London houses, on behalf of American consumers, had bought 35,000 tons of East Coast hematite pig iron. That, however, has not proved to be correct, but the advance is nevertheless being maintained. The business was for 20,000 tons of spiegel iron, of which class of iron a large tonnage has already been sent this year from Middlesbrough to the United States. The stock of Cleveland iron at 13th inst. consisted of 626,191 tons of No. 3; 59,577 tons of No. 4 foundry; and 1000 tons of iron that is not deliverable as standard. The increase has been nearly all in No. 3. The good prices obtainable have tempted the ironmasters to produce more iron than the market needed, and the surplus has gone into the public warrant stores. If less Cleveland iron had been made the advance for the year, instead of being only 8s. 3d. per ton, might have been more than double that, as it is in hematite iron.

Some improvement has been reported in the exports of pig iron this month from the Cleveland district, and shippers are making haste to complete deliveries due before the end of the year. The quantity this month has been 38,805 tons, as compared with 37,144 tons last month, 38,980 tons in December last year, and 31,997 tons in December, 1903, all to 13th.

The position of the manufacturers of finished iron and steel, and especially the latter, is good, and there is every prospect that it will keep so all next year. This year has seen fairly satisfactory advances in prices—rails are up 30s.; plates, 25s.; angles, 27s. 6d.; and bars 17s. 6d. What is also favourable is that "dumping" by Germany of semi-manufactured material has practically ceased. Germany has no surplus of that now, and the prices asked are above those which English producers will accept. On the other hand, English platemakers are supplying German shipbuilders with more material than in any previous year, and a report which has appeared in the daily Press that the German platemakers were dumping plates into this country is without foundation—it is us that are supplying Germany. A brisker demand is again springing up for steel rails, and the price has been advanced to £6 net, f.o.b., for heavy steel rails.

Steel ship plates are at £7; steel ship angles at £6 12s. 6d.; iron ship plates and angles, £7 5s.; steel joists, £6 7s. 6d.; iron bars, £7; and steel bars, £6 15s., all less 2½ per cent. Cast iron chairs are firm at £3 15s. net, and steel sleepers at £7 net.

The Newcastle and District Association of Foremen Engineers and Mechanical Draughtsmen on Saturday last visited the works of the Darlington Forge Company, at Darlington.

Sir Raylton Dixon and Co., at Middlesbrough on Saturday, launched the largest steamer that has ever been built on the Tees—the Velasques, of 11,000 tons deadweight capacity, and 16,600 tons measurement capacity. Triple-expansion engines are to be fitted by Messrs. Richardsons, Westgarth and Co., Middlesbrough.

The lull in the demand for new vessels is still to be notified, and only an odd order or two is secured. That was to be expected after the way in which shipowners contracted for new tonnage in September and October. Shipbuilders are now well situated, and the lull affects them practically not at all; they can afford to wait several months. The higher prices have choked off the speculative shipowners. It is satisfactory to note that wages questions are being adjusted amicably.

The coal trade is now showing more activity, and appears to be participating in the general revival. The dearth of business with Russia owing to the disturbed state of that country rather injuriously affects this district detrimentally, but it is to a large extent made up for by increased business with Germany, the latter being brought about by the scarcity of wagons in Westphalia. This will only be temporary, as it is due to the wagons being taken up in carrying the beetroot crops. Consumers in North Germany are now requiring more British coal than for several years past. Prices of Durham and Northumberland coals have been raised, and sellers are contracting for next year's deliveries at 6d. to 9d. more than the prices now being realised. Best steam coals are up to 9s. 6d., seconds to 8s. 6d., and smalls to 5s. 6d., all f.o.b., and best gas is now at 9s. A considerable number of the collieries are well off for orders for next half-year's execution. For medium coke not less than 17s. per ton will now be accepted for delivery at the Middlesbrough furnaces next half-year.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market was very strong towards the close of last week, and a large business was done in warrants at advancing prices. The upward movement was ascribed to the favourable Board of Trade returns, together with a rumour that large purchases of hematite had been made for shipment to the United States. There was a very sharp advance in the values of English hematite pig iron.

The difference between prices here and the United States is so small that many take leave to doubt whether iron can profitably be exported to any great extent to the States. The business with America this year, so far as regards Scotch iron, has been small. The shipments of pig iron to the United States from Scottish ports for the year to date amount to 8660 tons, compared with 6320 in the corresponding period of last year. The quantity exported to Canada has been 17,869 tons, against 10,325 in 1904. The shipments to Australia have fallen off very considerably, as well as those to Germany, but those to China and Japan have nearly doubled, the figures being 14,990 tons, compared with 7773 last year.

The present position of the market is, on the whole, tending towards quietness. There is small likelihood of much fresh business being done with consumers before the close of the year. The annual statistics of the trade, which are issued in the early days of the New Year, will be anticipated with considerable interest, as the output of pig iron, especially during the last six months, has been very heavy. At present the impression is that by far the greater part of it has been going into immediate consumption.

Business has been done this week in Cleveland warrants from 53s. 6¼d. to 53s. 2½d. cash, at 53s. 7d. for delivery in twenty-one days, and 54s. 1d. to 54s. 6¼d. one month. Cumberland hematite has sold at 71s. 1d. for cash and 71s. 6d. for delivery from eleven to twenty-one days. Scotch warrants are quoted 58s. 3d., and standard foundry pig iron 52s. 6d. per ton.

There is a large and steady output of pig iron in Scotland. The furnaces in blast number 91, compared with 85 at this time last year, and of the total 49 are producing hematite, 36 ordinary, and 6 basic iron.

The prices of Scotch makers' iron do not show much variation. G.M.B., No. 1, is quoted at Glasgow 62s.; No. 3, 59s. 6d.; Carnbroe, No. 1, 65s.; No. 3, 62s.; Clyde and Calder, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Gartsherrie, No. 1, 68s.; No. 3, 63s.; Summerlee and Langloan, Nos. 1, 70s.; Nos. 3, 65s.; Coltness, No. 1, 76s.; No. 3, 66s.; Glengarnock at Ardrossan, No. 1, 68s.; No. 3, 63s.; Eglinton at Ardrossan or Troon, No. 1, 62s. 6d.; No. 3, 60s.; Dalmellington at Ayr, No. 1, 65s.; No. 3, 60s.; Carron at Grangemouth, No. 1, 70s.; No. 3, 65s.; Shotts at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d. per ton.

The shipments of pig iron from the Scottish ports in the past week were comparatively small, amounting to 3374 tons, against 4168 in the corresponding week of last year. There were despatched to Canada 210 tons, South America 280, India 72, Australia 1025, France 10, Italy 215, Germany 20, Holland 110, Belgium 95, other countries 63, the coastwise shipments being 1274 tons, against 2951 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth amounted to 11,717 tons, against 10,140 in the corresponding week, showing an increase of 1577 tons. The total imports of the year to date are 462,021 tons, being 1749 tons less than at this time last year.

Regarding the finished iron and steel trades, there is not much to report. Business is proceeding quietly, so far as fresh orders are concerned. At the works there is general activity, and in a large number of cases night and day shifts are in constant operation.

The shipbuilding and engineering branches are getting busier, as specifications are coming forward in greater numbers. The employers on the Clyde have declined to return to the old system of weekly pays. Some years ago they adopted fortnightly payments, which save a great deal of labour in the clerical work, but the principal reason for this change was also understood to be the difficulty of getting the unsteady section of the workmen back to their employment at the beginning of the week. With the fortnightly pays this trouble and loss of time occurs only twice in the month, whereas with the weekly pays it took place four times in the month. The weekly pays were thus a serious loss, both to employers and workmen. Notwithstanding this, however, there is a strong feeling in the trades unions in favour of returning to the weekly pays, and it is said that further pressure will be brought to bear upon the employers with this object.

The advance in the prices of copper, tin, and metals generally is exercising an embarassing effect on not a few branches of the trade. Manufacturers' quotations are being altered where this is possible, and, on the other hand, buyers are hesitating to pay higher rates.

There is a steady business in the coal trade of this district.

The shipments from Glasgow are 12,000 tons better than in the preceding week, and the inquiry for the Mediterranean, the River Plate, and elsewhere, has been fairly encouraging. A large business is being done in household coal for home use, and the prices are maintained at moderate rates. A large and steady output has contributed to this result. Prices of shipping coals are also unchanged.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

IF climatic conditions only favoured, the tranquillising effect of the coal settlement would be more apparent. As it is, though fogs prevail and tonnage due is tardy, there is a good deal more animation in business, and tolerably large clearances have been made. On 'Change, Cardiff, this week it was understood that business over January was in request, and that leading shippers had been approached; but it was also known that coalowners were not very much inclined to book forward heavily at existing quotations. It is quite expected that, as the large stocks are cleared, there will be an advance in price, the extent depending upon circumstances.

A very depressed and anxious condition of things has been endured, and coalowners are to be congratulated that prices have not dropped to 12s., as a rule, and certainly not into the 11s. rut, as foreshadowed. The result of the Italian coal contracts arrangement, by which the management will be conducted by representatives in Cardiff, instead of by Cardiff firms, has not been favourable to the new policy. Cardiff men who tendered contracts did so at 6s. 6d. for Genoa. Now the figure will work out at 8s.

The Rio Janeiro contract for 60,000 tons best double-screened Cardiff steam coals for the Brazilian Government has been secured by Cory and Co.'s Trading Company; delivery first half of next year at 34s. c.i.f. It may be added that freights are 12s. to 14s., and that a heavy penalty is inflicted for small. The South of Spain order for 100,000 tons Monmouthshire coals has been placed with the Cory Trading Company.

On Tuesday, Cardiff Exchange members continued to complain of the fogs delaying tonnage, but trade prospects were admitted to be better, and prices 3d. to the good for best steam; figures now touch 12s. 9d. One item of good news came under discussion, the settlement of the Blaina strike. This has lasted eleven months. As usual, the cause was trivial.

Swansea coal trade is brisk, and both steam and anthracite in good demand. Newport appears to have caught the trade wind earlier than Cardiff, and good reports are current of increasing demand and steady prices. With the settlement of the strike, and the improving demand for semi-bituminous, prospects are regarded as favourable.

In the Cardiff district the question of small coal is coming more steadily to the front, and a leading mining agent comments publicly upon the fact that Westphalia is advancing small coal prices one mark per ton, and that in Scotland and the North small coal is showing improved figures, and more care is taken in sorting and washing. This is true, but the agent omits to note that the improvement in small coal trade is due to the improvement in boilers, by which the use of large is lessened. If small coal prices continue to advance, the agent foresees trouble with the men. At present the question is deferred.

Latest coal prices at Cardiff this week:—Best steam, 12s. 3d. to 12s. 9d.; best seconds, 11s. 9d. to 12s.; seconds, 11s. 6d.; drys, 11s. to 11s. 9d.; best smalls, 8s. 3d. to 8s. 6d.; best ordinaries, 7s. 9d. to 8s.; seconds, 7s. 3d. to 7s. 6d.; inferiors, from 6s. 9d. Monmouthshire semi-bituminous: Best large, 11s. 9d.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 3d. to 10s. 9d. House coal: Best, 16s. to 16s. 3d.; best ordinaries, 13s. 6d. to 15s.; seconds and other kinds, 10s. 6d. to 11s.; No. 3 Rhondda, 13s. 6d. to 13s. 9d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 9d.; No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 6d. to 8s. 9d.; small, 7s. 6d. to 7s. 9d.; patent fuel, 13s. 3d. to 13s. 6d. Coke: Furnace, 16s. 6d. to 17s.; foundry, 18s. 6d. to 22s. Pitwood, 21s. 6d.; slightly easier.

Swansea quotations:—Steam coal, 12s. 6d. to 13s.; house, 13s. 6d. to 14s. Anthracite: Best malting, 19s.; seconds, 16s. to 17s.; big vein, 13s. 3d. to 13s. 9d.; red, 9s.; cobbles, 17s.; nuts, 17s. 6d. to 19s. 6d.; peas, 10s. 6d. to 11s.; rubbly culm, 4s. 3d. to 4s. 6d.; duff, 3s. to 3s. 6d.; patent fuel, 11s. 6d.

The iron and steel trades continue to show a good deal of activity, and though heavy steel rails have not been so prominent a feature, one cargo of 1000 tons, with 600 tons miscellaneous, left Newport last week for Buenos Ayres and Rosario. Newport continues to be the dumping ground of a good deal of bars and billets from Antwerp, much of which is despatched to the tin-plate works of Monmouthshire and Llanelly, and some to Lydney and Bristol. In the course of a few days consignments of 5389 tons have been received at Newport. In the matter of iron ore Ebbw Vale has been exceptionally brisk, receiving 2368 tons from Passages, and 8368 tons from Bilbao. Pig iron also has come in freely to Welsh ports from Grimsby and Ardrossan. Guest, Keen and Co., are importing ore from Rivadeo, 2750 tons this week, and large cargoes have been received at Briton Ferry, where business is brisk, and in addition to existing furnaces another is being prepared.

On 'Change, Swansea, mid-week, animation prevailed. Firmness was a marked feature. Steel rails were not quoted in list issued, but it is known that heavy are up to £5 17s. 6d. in competitive markets. Pig iron as follows:—Bessemer, mixed numbers, 17s. 1½d.; Welsh, 72s. 6d.; Middlesbrough, 53s. 5½d.; Scotch, 58s. 3d. Siemens steel bars, £5 2s. 6d. to £5 5s.; Bessemer, £5 to £5 2s. 6d. In tin-plates there is little doing. The advance of raw material prevents makers from quoting to meet the needs or wishes of buyers. Tin is now at £163 12s. 6d., and little likelihood of falling, according to report. Spelter, £28 12s. 6d.; copper, £79 15s.; lead, £17 10s.; silver, 30d. per oz. All Swansea, Cardiff, and Newport quotations for iron ore are: Rubio, 17s. 6d. to 18s.; Almeria, the same, on bases of 50 per cent. of iron.

Tin-plate prospects are considered promising, when prices of materials will admit of what buyers term more equitable figures, but manufacturers contend that quotations are below what they should be, and that if the cost of raw materials is not lessened, those in the trade not covered will lose considerably. Latest reports are to the effect that there has been a better inquiry this week, and that some important orders have been placed for delivery up to the end of June. Swansea shipment of plates for 1904 totalled 285,775 tons, nearly 30,000 tons in excess of previous year. This year promises well. Shipments last week, 67,649 boxes; receipt from works, 82,156; present stock, 216,636 boxes. Swansea industries are active; tube works well maintained. Port Talbot reports are hopeful. Llanelly brisk.

NOTES FROM GERMANY.

(From our own Correspondent.)

ON the iron and steel market over here the hopeful and firm tone of previous weeks continues.

Pig iron has been very animated in Silesia, and the manufactured iron and engineering departments are actively engaged on home, as well as on foreign account. For heavy and thin plates a good inquiry is experienced, while girders are a trifle languid. Wire and pipes of every description meet with active request.

Favourable accounts come in from the Rhenish-Westphalian iron industry, employment all round being regular, and likely to improve after Christmas. The Union for the sale of Siegerland iron ore intends to raise the price for spathose iron ore M. 0·07 p.t., and for roasted ditto M. 1 p.t. for sales in the second quarter of 1906. The blast furnace works would be seriously affected by this rise, because there appears to be but little chance of their being able to realise a correspondingly higher price for raw iron. The majority of the ironworks are well provided with orders till up to the second quarter in 1906, and some are even booked forward till April; this accounts for a certain reserve, and an unwillingness to be tied down later than the first months in 1906, which many works have recently exhibited. Quotations all round are stiff and fairly remunerative. According to the *Rhenish-Westphalian Gazette*, the Steel Castings Union has been prolonged for further three years, and a rise in quotations has at the same time been resolved upon, employment at the shops being strong. The Friedrich Krupp Joint Stock Company is building three gun works, and a rolling mill with a Martin works.

The German manufacturers of steel plate shovels resolved to form a convention of prices.

The demand for all sorts of coal in Silesia is lively and increasing, and the tendency of prices continues exceedingly firm. A very strong demand comes in from Austria-Hungary, also home demand has been extremely brisk lately.

Coke, which is in very active request, has shown much firmness, and even an upward tendency in price. Consumption and demand improve perceptibly from week to week. At a recent meeting of the Coal Convention a rise of M. 0·20 and M. 0·25 p.t. for several sorts of coal was resolved upon for April, 1906. Coal for coke making was raised M. 1 p.t., and coke M. 0·50 p.t., while briquettes will meet with a rise of M. 0·25 p.t. The healthy condition of the coal market is illustrated by the fact that the Prussian State Railways placed their requirements in locomotive coal for two years at prices that are about M. 0·60 p.t. higher than those previously quoted. Sales of the Rhenish-Westphalian Coal Syndicate in October of present year were 4,955,459 t. The German general output in pit coal for October of present year was 10,744,176 t., against 10,367,196 t.; in brown coal, 4,837,841 t., against 4,548,133 t.; in coke, 1,492,154 t., against 1,070,874 t., and in briquettes, 1,161,015 t., against 1,409,917 t. From January 1st to October 31st German output in pit coal was 99,951,160 t.; against 99,277,487 t.; in brown coal, 42,438,507 t., against 39,670,010 t.; in coke, 12,366,680 t., against 10,166,351 t.; and in briquettes, 10,589,950 t., against 9,411,952 t. Import in pit coal for October of present year was 795,847 t., against 776,209 t., and since January 7,846,945 t., against 5,904,602 t. Export in October was 1,769,338 t., against 1,613,541 t. in the same month last year, and since 1st of January 14,738,444 t. were exported, against 14,641,994 t. Export in coke for October of present year was 247,073 t., against 238,925 t., and since 1st of January 2,267,623 t., against 2,259,926 t.

Prices are, for best steam coal, M. 11 p.t.; mixed sorts, M. 10 p.t.; foundry coke, M. 17 p.t.; blast furnace coke, M. 15 and M. 16 p.t., according to quality; anthracite, M. 12 to M. 12·50 p.t.

In Austria-Hungary pig iron remains well inquired for at firm prices. Manufactured iron, too, sells pretty well, and the trade in plates and sheets has been lively as before. In girders no sales are being effected just now, but inquiries for the first quarter have already come in freely.

Coal is still in active request on the Austro-Hungarian market, though demand is a trifle less vigorous now than at the time when a general strike was threatening, and consumers tried to provide themselves with large stores. Small coal continues scarce. Heavy deliveries in gas coal are being effected, and coal for coke-making is also in strong request, in consequence of a brisk trade on the coke market.

A satisfactory employment is reported to prevail in all the principal departments of the French iron and steel trade, and the tendency is upwards.

An animated tone is likewise noticeable on the French coal market.

Increasing firmness, with a rise here and there in quotations, has been the characteristic feature of the Belgian iron industry all through last week. Business transactions in the bar and plate trade have improved, and the majority of the works will be well employed up to March, and some till far into the second quarter of next year. The uncommonly brisk demand that comes in from America is partly accountable for the present animated and very strong condition of the Belgian iron market.

Coal and coke, too, are in healthy demand, and prices very stiff; for deliveries in the next quarter a rise in quotations has been resolved upon.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal in better demand, tonnage having come on and stems are well filled for forward delivery. House coal keepsin fair request. The quantity of coal shipped for week ending December 9th was 68,820 tons; foreign, 53,099 tons; coastwise, 15,721 tons. Imports for the week ending December 12th were:—Iron ore, 15,406 tons; pig iron, 950 tons; steel bars, &c., 5399 tons; scrap, 875 tons; slates, 150 tons; pitwood, 7303 loads.

Coal:—Best steam, 11s. 6d. to 11s. 9d.; seconds, 10s. 3d. to 10s. 6d.; house coal, best, 14s.; dock screenings, 7s. 9d. to 8s.; colliery small, 7s. 3d. to 7s. 6d.; smiths' coal, 9s. Iron ore:—Rubio, 18s. 6d. to 19s. Steel:—Rails, heavy sections, £5 10s. to £5 15s.; light ditto, £6 10s. to £6 15s.; Bessemer steel tin-plate bars, £5 to £5 2s. 6d.; Siemens steel tin-plate bars, £5 2s. 6d. to £5 5s., all delivered in the district, cash. Tin-plates:—Bessemer steel, coke, 13s. 3d. to 13s. 6d.; Siemens, coke finish, 13s. 6d. to 13s. 9d. Pitwood, 21s., ex ship. London Exchange telegrams:—Copper, £79 15s. to £79 17s. 6d.; Straits tin, £163 15s. to £163 17s. 6d. Freights quiet; rates firm.

CATALOGUES.

INDUSTRIAL ENGINEERING COMPANY OF AMERICA, 32, Broadway, New York.—General catalogue of tools, electric motors, &c.

FORGROVE MACHINERY COMPANY, Limited, Dewsbury-road, Leeds.—Wrapping machinery for chocolate and similar articles is described and illustrated in this pamphlet. The descriptive matter is given in three languages.

MESSRS. L. STERNE AND CO., of London and Glasgow, have sent us a pocket diary and note-book for 1906, a few pages of which are devoted to setting out some of the firm's principal manufactures. The note-book is provided with a self-opening memorandum tablet.

MELDRUM BROTHERS, Limited, Timperley, near Manchester. A new department has been established by this firm for the manufacture of steam fittings from wrought steel, and this pamphlet illustrates certain flanges and tees which are now on the market.

D. MITCHELL AND CO., Limited, Keighley.—This is a thirty-six page catalogue of machine tools, including drills of several types, lathes, shapers, planers, slotters, saw benches, &c. The utility of the book would be further enhanced by the addition of an index or table of contents.

HOBSON, HOUGHTON AND CO., Limited, Don Steel Works, Sheffield.—This firm has issued a new general catalogue, in which particulars are given of anvils, files, hammers, picks, reamers, rasps, saws, drills, wedges, &c.; a new price list of twist drills, reamers, and chucks is also available.

ALLEY AND MACLELLAN, Limited, Glasgow.—Catalogue "No. 5, Air" deals with the well-known "Sentinel" air compressors. In the production of this book good taste is combined with sensible ideas of the wants of buyers. The sectional illustrations are clear, the index concise, and the tables of dimensions very complete.

FRIEDRICH LUX, Ludwigshafen-on-Rhein.—Frahm's speed indicator, described in this pamphlet, is an ingenious device based on the employment of the principle of resonance. A number of flat springs are arranged like a domestic comb, and these are caused to vibrate by suitable mechanism from the revolving wheel or shaft. The vibrations are communicated to counting mechanism.

AMERICAN LOCOMOTIVE COMPANY, New York.—This book is entirely devoted to a description of the Mallet articulated locomotive in many types. The essential features are a locomotive with all of its weight on drivers, having tractive power in excess of any previous American locomotive, and at the same time possessing a certain flexibility of construction which makes it possible to operate it on roads having maximum grades and curves. It is practically two separate locomotives combined in one, and advantage is taken of the opportunity to introduce the compound principle under most advantageous and favourable conditions.

THOMAS ROBINSON AND SON, Limited, Railway Works, Rochdale.—A number of leaflets with admirable illustrations of woodworking machines of many kinds has been sent us by this firm. All the latest improvements are shown. The illustrations include a horizontal log band-saw—new type; Robinson and King's saw-bench for light box-making; combined saw-bench, horizontal and vertical feed—new type; two-spindle saw-bench—new type; hand and power-feed planer, high-speed planing and moulding machine, double-circular moulding machine, three-drum sandpapering machine, hand jointer—new type; automatic power jointer—new type; vertical square hole mortising machine—new type; and automatic dovetailer—new type.

THE NATIONAL EXPLOSIVES COMPANY, Limited, Hayle, Cornwall.—This book describes the manufacture of gun-cotton charges by the solid block process—Bell's patents—which is claimed to be the latest and most successful method. Briefly, the new features introduced are the working up of gun-cotton pulp in such a manner that air is completely expelled, while the mass is worked together so as to produce a cohesive and homogeneous block. By the hitherto existing processes the air has not been removed; the cavities in which it rests are naturally made smaller by pressure, but when the pressure has been removed, they expand again, rendering the block spongy or laminated. The consequence of this is that detonation is often not complete, and has a diminished destructive effect when the charge is fired.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. M. RATCLIFFE BARNETT, M. Inst. C.E., informs us that he has opened an office at Edinburgh Life Building, 124, St. Vincent-street, Glasgow, and that he is prepared to undertake all work usually entrusted to a civil engineer.

MR. GILBERT C. VYLE informs us that he has resigned his position as works manager and assistant to the general manager of the Telephone Department of the General Electric Company's Works at Salford, and has established himself at 14, Ridgefield, Manchester, as a consulting engineer.

WE are informed that Messrs. Geipel and Lange, of Vulcan Works, 72a, St. Thomas's-street, London, S.E., have been appointed the sole British representatives for M. Fabius Henry, of Nancy, for the sale of arc light carbons, dynamo and motor carbon brushes, and incandescent lamps.

MR. W. C. MITCHELL, general superintendent of the British Westinghouse Electric and Manufacturing Company, Limited, late of the Illinois Steel Company, Chicago, and the Nicopol Mariopol Mining and Metallurgical Company, Mariopol, Russia, has resigned his position to associate himself with Charles P. Markham, Chesterfield, Derbyshire, England.

WE learn that Mr. John Cowan has resigned the managing directorship of the Stirling Boiler Company, Limited, of Motherwell, and 25, Victoria-street, Westminster. The directors have appointed Mr. E. G. Constantine, A.M.I.C.E., M.I. Mech. E., of Manchester, to be managing director, and he will enter upon his duties at Motherwell on 1st January next. Mr. Cowan still retains his interest in the company, and will continue to be chairman of the directors.

ELECTRIC traction on the Teltow Canal, which is one of the principal canals in Germany, is about to be applied on a large scale. A large central station for supplying the current has been erected, which contains a 400 horse-power dynamo and engine and two large steam turbine and dynamo sets of 700 horse-power each. The station is now prepared to furnish current. The extensive system of locks will first have an electric system for operating it. The rails for the electric locomotives have been laid along the canal in the eastern section between Grünau and Britz, on both banks. The overhead wires and the poles are being put in place.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—On Friday last the seventeenth annual dinner of the Institution of Electrical Engineers took place at the Hotel Cecil. The President, Mr. John Gavey, C.B., was in the chair, and a numerous company included many distinguished guests, among whom were Lord Strathcona, Major-General Sir A. E. Turner, Dr. E. Budde, President of the Verbany Deutscher Elektrotechniker, Berlin; Mr. Babington Smith, Secretary of the General Post-office; Sir Norman Lockyer, Lieut.-Colonel H. A. Yorke, C.B., Mr. Cunliffe Owen, C.M.G., and the Hon. J. G. Maydon, Minister of Railways in Natal. After the usual loyal toasts had been duly honoured, Mr. Babington Smith proposed the toast of "The Institution," which was responded to by the President. The "Electrical Industries" was proposed by Sir Alexander Kenedy, and responded by Mr. Cunliffe Owen and Dr. Budde. Mr. Alexander Siemens proposed "Our Colonies," which was responded to by Mr. Maydon; "Our Guests" being submitted by Mr. W. M. Mordey, and replied to by Sir Alexander Binnie.

CONTRACTS.—Johnson and Phillips, Limited, inform us that they have obtained the contract for conduits, feeder and arc lighting cables, underground boxes, and lamp pillars for the Portland coaling depôt, and for the supply of motors, transformers, and complete electrical plant for Lilicoah, on the East Indian Railway.—Messrs. Clarkson, Limited, of Chelmsford, notify us that owing to the satisfactory results of the trials which have been made with the Chelmsford steam omnibus by the Ambulance Committee of the Metropolitan Asylums Board a further order has been placed with them.—Messrs. Mellowes and Co., Limited, of Corporation-street, Sheffield, and 28, Victoria-street, Westminster, S.W., have recently been favoured with the order for supplying and fixing their patent "Eclipse" roof glazing on the extensions of the Ordnance Works, Coventry; Messrs. Cammell, Laird and Co., Limited, Sheffield; and extensions to Crewe Station, London and North-Western Railway, &c.—The Mirrlees Watson Company, Limited, of Glasgow, have sent us a list of important orders for condensing plant which the firm has recently received. These vary in power from 15,000 lb. per hour to 70,000 lb. per hour, and we notice that the total capacity of fourteen of the plants is over 360,000 lb. per hour.—The tender of Messrs. James Watt and Co., of Birmingham, for supplying a horizontal tandem compound engine, together with deep-well pumps, for the Westerham-hill Waterworks, Kent, has been accepted by the Metropolitan Water Board.—Thomas Piggott and Co., of Birmingham, have just successfully completed two steel chimneys in South Wales—one 175ft. high and the other 125ft. high.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS,** *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

29,182. December 31st, 1904.—IMPROVEMENTS IN OR CONNECTED WITH FIRE-BARS AND FURNACE GRATES, Robert L. Marriott, Ravenswood, West-street, Fareham, Hants.

This invention relates to fire-bars and furnace grates for steam generators and other furnaces, and has for its object to furnish a simple and inexpensive fire-bar, and to provide for the change of surface of the fire-bars during the combustion of the fuel consumed thereon. The fire-bars are made of a series of metal or fireproof discs formed with a recess or groove on one or both faces and with an extending boss, or of solid form with an extending boss or of plain discs separated by ferrules. The fire-grate is composed of a series of disc-bars placed transversely to the length of the grate, and the discs are moved automatically as the fuel is thrown on, or by the raking of the fire, or the bars may be connected and moved by suitable gearing, in which case the discs are fixed on their carrying shafts or spindles. There are six figures.

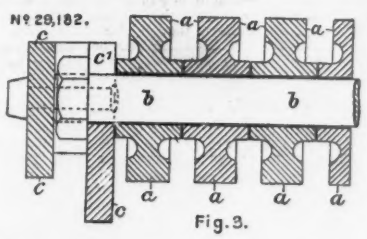
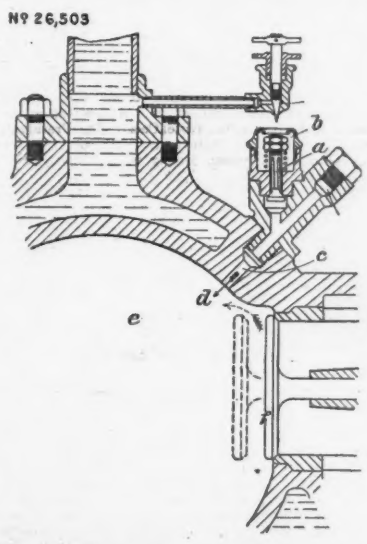


Fig. 3 is an end elevation showing the mounting of the discs and the side carrying frame or supports; *a* denotes the discs, *b* is the shaft on which a series of the discs *a* are loosely mounted to form the fire-bar which is used in multiple to form the fire-grate; a convenient and suitable mounting for carrying the fire-bars comprising the discs *a* and shaft *b* consists of the recessed side frame or bearers *c*, which are provided one on each side of the grate and support the ends of the shaft *b* in the recesses c^1 formed in the bearers *c*. When it is desired to move the bars mechanically the discs *a* are fixed on the shafts *b*, which are connected and worked by any suitable gearing.—*November 15th*, 1905.

INTERNAL COMBUSTION ENGINES.

26,503. December 6th, 1904.—IMPROVEMENTS IN AND IN THE OPERATION OF INTERNAL COMBUSTION ENGINES, William J. Crossley and James Atkinson, of Messrs. Crossley Brothers, Limited, Openshaw, Manchester.

This invention is for a special method of introducing a little water into the cylinders of internal combustion engines, and has for its object the prevention of pre-ignition of the charge; the reduction of the sharpness of the initial ignition so as to reduce the severity of the otherwise high pressure and strains consequent on the employment of large cylinders and high compressions; the general reduction of temperature of the metal of the cylinder end and passages, thus to some extent removing the strains caused by high temperature and making it possible to use in a gas engine cylinder very readily ignitable gases which under ordinary conditions would be very difficult to work with. There is one figure, a sectional view of the apparatus as applied to an engine having a horizontal admission valve. The opening *d* in the cylinder *c* of the engine is placed in such a position that the charge entering by the admission valve *f*—which is shown in full in its closed position and in dotted lines in its open position—is below it and the sprayed

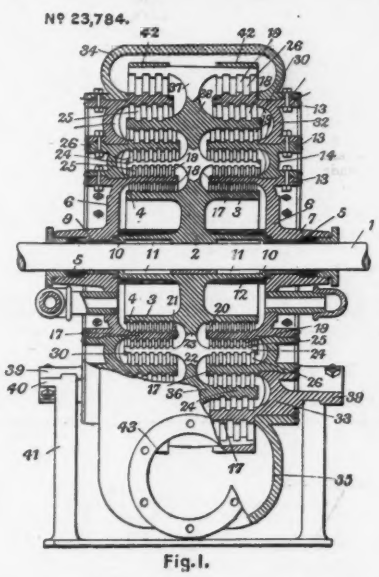


water, together with the air entering with it, is delivered on to the top of the entering charge during the whole of the suction stroke. In a suitable position on the cylinder is fixed a small inward opening self-acting valve *a* having a cup-shaped receptacle *b* above it for the water and a passage *c* below the valve into the cylinder. This passage terminates in the cylinder in such a position that the entering charge of gas and air during the suction stroke sweeps past the opening *d* so as to thoroughly and uniformly mix the water with the charge, and as far as possible prevent any of the water coming into contact with the walls of the cylinder or the end of the piston. The water is drawn into the cylinder by the suction, which also draws in the charge, and a little air is drawn in with the water so as to break it up into spray. The small self-acting valve *a* opens with the suction to admit the water, but closes as soon as compression commences and remains closed during the working stroke, so that nothing can escape outwards from the cylinder.—*November 15th*, 1905.

STEAM TURBINES.

23,784. November 3rd, 1904.—IMPROVEMENTS IN ELASTIC-FLUID TURBINES, *George Edwards, Crocker-buildings, San Francisco, California, U.S.A.*

This invention relates to steam turbines, preferably of the well-known Parsons type, in which high-pressure steam impinges alternately against moving vanes and stationary deflectors, the vanes being arranged in a plurality of cylindrical series, moving with the same central shaft, and the deflectors being arranged in a like plurality of corresponding series in a casing, and in close proximity to the vanes, the vanes and deflectors progressively increasing in size in the several series, according to their distance from the axis. The object of the invention is to reduce the Parsons type of turbine to a small fraction of its present length, to greatly reduce the weight, to give the turbine so compact a form that it is available for vertical use, to facilitate construction of very high powers by use of a duplicate form, to eliminate entirely end thrust, and to provide a reversing device, extremely compact, and having greater power than similar devices in use at present. There are ten figures. Fig. 1 is a longitudinal vertical section; 1 is the turbine shaft, having keyed thereon a web 2, which has formed integral therewith cylindrical vane carriers 3, which extend equally on both sides of the web. Upon the outside of the vane carriers are secured parallel rings of outwardly-extending vanes 4, of the shape common in the Parsons type. The shaft 1 revolves in stuffing-boxes 5, at the centres of the innermost casing sections 6, which are made semi-circular in form, with hub portions 7 and flanges, by which they are bolted together. In the bearings are bushings 9, against which abut cylindrical extensions 10 from the web 2, the extensions being spaced from the shaft, except at the outer peripheries, where they turn down on the shaft, thus providing air spaces 11 around the shaft, protecting the same from the heat of

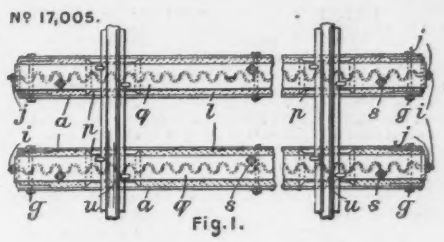


the steam. As an additional protection, there are provided jackets 12 of asbestos. The innermost casing sections 6 have also peripheral flanges 13, by which they are bolted to the next outer casing sections 14. The sections 6 have semi-cylindrical extensions 17, which serve as supports for two series of deflectors 18, 19, of which the series 18 extend radially inwards in parallel rings alternately with the rings of vanes 4, while the series 19 extend radially outwards in parallel rings. The straight edges of the deflector support sections 17 will come together and fit closely against each other, but to additionally secure these sections together their inner peripheries next the web 2 are slightly tapered on the outside, as shown at 20, and hoops 21 are fitted tightly on to the tapering edges. Upon the periphery of the web 2 are now secured the semi-annular web sections 22, having bevelled or tongued inner edges, fitting in a groove 23 in the circumference of the web 2. The web sections have formed integrally therewith vane carrier sections 24, semi-cylindrical in form, extending in both directions from the web sections, and having secured thereon parallel rings of inwardly and outwardly-extending vanes 25, 26. The rings of inwardly-extending vanes 25 alternate with outwardly-extending deflectors 19. The web sections are secured on the central web 2 by screws, and are held from turning on the web by means of recesses engaging projections on the web. The outer edges of the semi-cylindrical carrier sections 24, in like manner as the deflector support sections 17, are slightly tapered, and are held together by hoops 30. In this manner the moving and stationary parts of the turbine are built up, the casing by casing sections 6 14, upper and lower casing sections 32 33, next to the outermost, and upper and lower outermost sections 34 35, and the web sections 22 36 37. The web sections 36 are separated along a plane at right angles to that of the sections 22, and in like manner the sections 37 are separated on a plane at right angles to that of the sections 36. The lower casing 33 next to the outermost has outward extensions 39, which rest upon, and are bolted to, outwardly-extending lugs 40 from standards 41 on the base of the turbine. The vane carriers of the outermost web sections carry vanes on the inner side only, and around these two sections 37, which taper slightly towards the edges, are strong bands or hoops 42, which firmly hold all the web sections together. Outside the outermost web sections 37 are the outermost casing sections 34 35, which form the outside wall of the exhaust passage for the steam, the end of which, shown at 43, may be connected with an exhaust pipe.—*November 15th*, 1905.

RAILWAYS AND TRAMWAYS.

17,005. August 22nd, 1905.—IMPROVEMENTS IN RAILROAD TIES OR SLEEPERS, *David V. Howell, Monroe, Orange County, New York, U.S.A.—Date under International Convention, September 8th*, 1904.

This invention contemplates an improved form of railroad tie or sleeper designed to be used in place of the common wooden tie or sleeper. It has for its object to provide a relatively inexpensive railroad tie, which, while it has greater lasting power and strength than the ordinary wooden tie, retains the resiliency which is regarded as essential in railroad construction. There are six figures. Fig. 1 is a plan view showing two of the improved ties supporting the rails; *a* is a rectangular shell having substantially the dimensions of the ordinary wooden tie. This may be formed of boiler iron, or other suitable material. The side and end wings of the blank are bent up at right angles to the body—the portion which will form the bottom of the finished shell—the end portions of the wings being afterwards bent in at right angles inside the end portions of the wings, whereupon the shell is permanently retained in this form by bolts *g*, traversing the same transversly in its end portions, and securing the wings together; *l* is a body of cement which fills the shell. In order to have the bar *i* reinforce the cement, the bar can be of sinuous or corrugated shape. The top of the cement is left formed with dovetailed recesses or pockets, extending down beneath the top edges of the shell, and lined with asphalt. In these recesses seat, not too snugly, wooden blocks *p*. The blocks are held firmly in place by a metallic bridgepiece *q*,

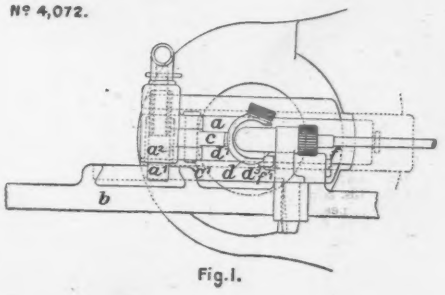


consisting of a strip of metal, having its ends bent down and slotted to receive the bars *i*, the nuts *j* of which are designed to secure the bridge pieces in place. To reinforce the bridge pieces, bolts *s* may be employed, extending vertically through the bridge pieces, the cement, and the bottom of the shell, the bolts being preferably mounted in the shell before the cement is filled in. These bridge pieces are formed with holes, one on each side of the rail *u*, to permit the spikes whereby the rails are secured in place to be driven down into the wooden blocks *p*.—*November 15th*, 1905.

ORDNANCE.

4072. February 27th, 1905.—IMPROVEMENTS IN THE FIRING MECHANISM OF ORDNANCE, Sir W. G. Armstrong, Whitworth and Co., Limited, and Stephen M. Murray, Elswick Works, Newcastle-on-Tyne.

This invention relates to improvements on the firing mechanism of ordnance which has the De Bange or kindred system of obturator, and which has a primer inserted in the rear end of the obturator stem, and a lock frame sliding across the rear end of the stem to come behind the head of the primer and prevent its being blown back when the gun is fired. There are five figures. Fig. 1 is a rear elevation; *a* is the sliding frame, operated by means of an inclined groove in the hand lever *b*, which engages the lower end of a spring bolt c^1 on the frame. The bolt can be lifted by hand to disengage it from the groove to allow of the removal of the frame or the renewal of the primer without opening the gun. As the bolt is raised it is turned, owing to a pin a^2, which is guided in a groove in the frame, coming against one arm of a lever *c* pivoted in the frame at c^1. The other arm of this lever, which is thus rocked, comes against a shoulder d^1 on a sleeve *d*, which has an inwardly projecting flange engaging the rear end of the firing pin. When, therefore, the bolt a^1 is withdrawn the firing pin is drawn back against the main spring. In order to

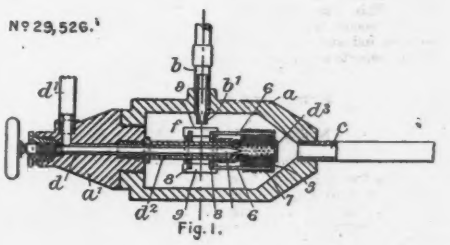


prevent the point of the firing pin being abraded or bent when the lock frame is moved endwise, a spring bolt *f* is mounted on the lever *b*, and its nose f^1 comes against a lump d^3 on the sleeve *d* and holds the sleeve and firing pin back until the firing pin is clear of the head of the primer. For percussive firing a tripping lever is used pivoted on the lock frame, which can be turned by a pull on a lanyard from either side. The spring bolt is carried by the tripping lever, and engages with the shoulder on the sleeve to withdraw the striker against the main spring to give the required blow to fire. The tripper bolt slips off the shoulder when the striker reaches full cock and allows it to fly forward. A toe on the lever engages a spring return bolt, which returns the lever to normal position after a blow has been given, and the tripper lever is then ready immediately for again actuating the striker to give another blow if necessary. To draw back the striker when the bolt is lifted by hand, as before, the pin on the bolt engages and holds back the spring return bolt, and so holds back the striker a sufficient amount for the lock to be easily removed with safety.—*November 15th*, 1905.

OIL BURNERS.

29,526. December 31st, 1904.—IMPROVEMENTS IN MEANS FOR ATOMISING OIL FOR BURNING IN FURNACES, *Albert F. Chace, Francis H. Appleton, and Francis H. Appleton, jun.*, 185, *Summer-street, Boston, Mass., U.S.A.*

This invention relates to oil burners or oil-consuming apparatus in which oil is atomised or reduced to fine spray and taken up by a current of air, the oil-laden air current being supplied to a burner. The object is to provide means for atomising the oil and for presenting it to the air current so that the oil atoms may be intimately mixed with the air and gas. There are four figures. Fig. 1 is a longitudinal section of an oil-atomising device; *a* is a casing cylindrical in form; *b* is an air pipe connected with one side of the



casing and communicating with the source of supply of air under pressure; c is an outlet for the mixture of air and atomised oil, the outlet being a tube extending to a burner tip. The outlet c is connected with the casing at the smaller end, and is arranged in alignment with the longitudinal centre or axis of the cylindrical casing; a^1 is a head or plug which closes the end of the casing opposite the outlet c, and contains a passage d through which oil enters; d^1 is an oil-conducting pipe extending from a source of oil supply, and communicating with one end of the duct d; d^2 is a pipe or tube constituting an extension of the duct d and projecting from the head a^1 into the casing. The tube d^2 is preferably in line with the outlet c, and therefore occupies the longitudinal centre of the casing. The tube d^2 is provided at its outer portion with a delivering section d^3, provided with numerous small orifices, arranged to discharge oil outwardly in numerous small streams, the orifices being arranged radially. A rotary atomising screen surrounding the oil-delivering section d^3 is arranged to act on the radiating streams of oil, this screen being sufficiently elongated so that when rapidly rotated it effects a thorough atomising of the oil and distributes it in the form of spray in the portion of the casing intervening between the air inlet b and the burner supplying outlet c. The finely atomised oil is therefore mixed with the air while in the chamber and before it escapes at the outlet. The screen is composed of two annular heads 5, mounted to rotate upon the delivering section d^3, rods or bars connecting the heads 5 and extending parallel with the axis of the screen, and a covering or screen 7 which is of cylindrical form and is supported by the bars 6 between the heads 5. The screen 7 is made of wire cloth with an inner layer and an outer layer, the inner layer being of coarser mesh than the outer; f is a wind wheel attached to the screen, rotated by the air current delivered to the casing by the pipe b, the rotation of the wind wheel being imparted to the screen. The rotating wheel is composed of two annular collars or hubs 8, mounted to rotate upon the oil pipe d^3 and blades 9 affixed to the hubs 8, and radiating from the axis of rotation of the wheel.

MISCELLANEOUS.

27,632. December 17th, 1904.—AN IMPROVED METHOD OF AND MEANS FOR UTILISING THE WASTE HEAT OF FURNACE GASES, Harry L. Davies, Newbie, Annan, Dumfriesshire, N.B.

According to this invention a boiler or steam generator—preferably of the vertical multitubular type having horizontal tubes—is so arranged that waste furnace gases can be passed through the same and in so doing give up their heat to the water in the boiler or steam generator. The latter has its furnace or fire-box so arranged that the waste gases pass into it and thence through the fire tubes to the chimney. There are two figures. Fig. 1 is a vertical section. A is the steam generator, which is of the vertical multitubular type, having horizontal fire-tubes a; a^1 is the furnace of the steam generator, and a^2 is the combustion chamber. B is an auxiliary furnace communicating with the furnace a^1 of the steam generator through the uptake b, and adapted to be fired with coal or other fuel through the opening b^1 when desired. C is

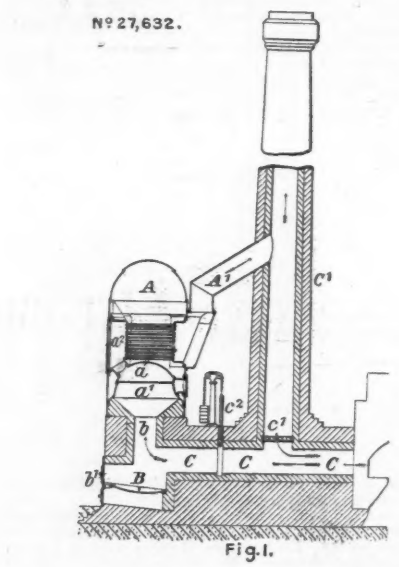


Fig. 1.

the flue through which the waste gases whose heat is to be utilised pass to the uptake b, and C^1 is the chimney stack leading from the flue C; c^1 is the damper for closing the entrance to the chimney stack C^1 from the flue C and c^2 is the damper for opening the flue to the uptake b. The chimney A^1 for the escape of the gaseous products of combustion from the steam generator A communicates with the chimney stack C^1. When the dampers c^1, c^2 are in the position represented in the drawings the furnace gases pass from the flue C through the steam generator A and the chimney A^1 to the stack C^1, as represented by the arrows, thus enabling the waste heat of the furnace gases to be utilised in generating steam.—*November 15th*, 1905.

13,106. June 24th, 1905. — IMPROVEMENTS IN CARTRIDGE-EXTRACTING AND EJECTING MECHANISM FOR GUNS, *The Fried Krupp Aktiengesellschaft Grusonwerk, Magdeberg - Buckau, Germany.—Date under International Convention, September 13th*, 1904.

This invention relates to mechanism for extracting and ejecting the empty cartridge cases from fire-arms or guns, and has reference to that class of extracting and ejecting mechanism in which two extractors and a fixed ejector are employed, one of the extractors being released during the opening movement of the breech block.

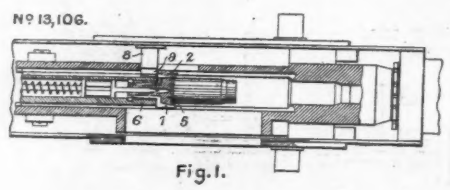


Fig. 1.

There are nine figures. *Fig.* 1 is a horizontal longitudinal section through the breech. Both the extractors 1 and 2 are placed in recesses in the breech piece 5, and remain therein secure from accidental displacement when the breech piece is attached to the breech block 6 by its bayonet joint. The extractor 1 is of the usual form, but the auxiliary extractor 2 is provided with two claws, each having on its inner side a projection formed with a curved edge directed towards the axis of the barrel. In the forward movement of the breech block 6 both extractors spring apart and seize the rim as soon as they strike against the base of the cartridge. On the retraction of the breech block, they carry the cartridge case axially until the base of the cartridge case strikes against the ejector 8 shortly before the projections of the auxiliary extractor enter the grooves 9 of the ejector. By this means the claws of the auxiliary extractor 2 are pressed outward so far that they release the rim of the cartridge case. The extractor 1, however, continues to hold the rim of the cartridge case while moving further back, so that the cartridge case slides against the ejector, and tilts or turns around the extractor 1, thus being ejected from the gun through the ejection opening in the breech guide and the opening in the casing by reason of the velocity with which the breech bolt moves backwards. If a special stop is provided for the displacement of the auxiliary extractor, this stop carries the necessary devices for effecting such displacement in the required manner.—*November 15th*, 1905.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

803,284. REGENERATIVE STOVE, *J. M. Hartman, Philadelphia, Pa., and John S. Kennedy, Stanhope, N.J.—Filed January 3rd*, 1905.

This invention is best described by the following claim read with the engraving:—In a regenerative stove, the combination with a casing inclosing brickwork, and having a cold air inlet and a chimney vent, of a combustion chamber exterior to said casing, having a

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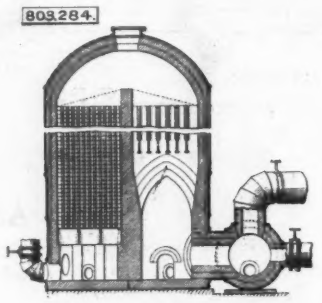

hot gas inlet, an air inlet, and a hot air outlet; a conduit between said combustion chamber and said casing; and means, exterior to said conduit, controlling the flow of hot gas and hot air alternately therethrough, substantially as set forth. There are six claims.

803,560. REVERSING PROPELLER, *E. B. Cushman and L. S. Cushman, Lincoln, Nebr.—Filed June 24th*, 1905.

There are three claims to this specification; the second sufficiently describes the invention:—In a screw propeller, a shaft, a recessed head block at the end of the shaft, propeller blades having

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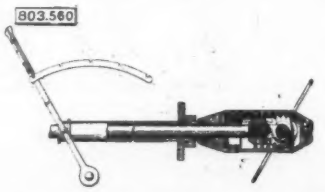

stems extending through openings in the head block, gear segments secured to said stems and serving to prevent longitudinal displacement of the same, and a longitudinally movable slotted casing surrounding said head block, and having racks with which the gear segments intermesh.

803,567. APPARATUS FOR ROLLING SHEET AND TIN PLATE, *P. E. Donner, Columbus, Ind.—Filed September 14th*, 1904.

Two sets of reducing rolls are arranged side by side, a matching device is placed at the delivery end of one set of rolls, and the

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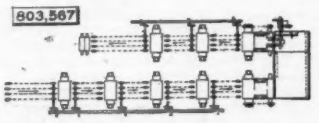
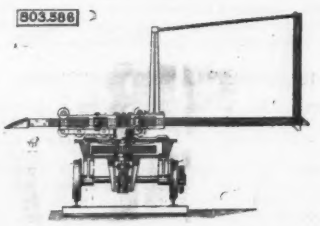


entrance to the second set. It receives the plates, moves them over sideways, and enters them in the second train. There are five claims.

803,586. COKE EXTRACTOR, *J. S. Ham, Covington, Va., assignor to Covington Machine Company, a Corporation of Virginia.—Filed April 5th*, 1905.

The invention patented is the combination of a truck mounted on wheels, a ram carriage arranged to rotate on the truck, a ram or bar arranged to move horizontally, the rear end of which is composed of articulate parts so arranged as to form a rigid bar

803,586

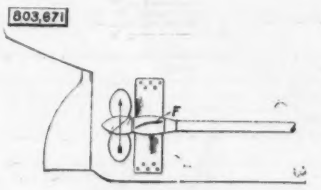


while the bar is being advanced or retracted, and means for deflecting the rear end of the bar from a right line on the articulate joints. The jointed rack bar is kept rigid when pushing by the guide rollers shown in the drawing.

803,671. MARINE PROPELLER, *C. G. Curtis, New York, N.Y.—Filed January 29th*, 1903.

This invention consists in fixed deflecting guide blocks on the boss of the stern bearing, as shown at F in the drawing. There are five claims.

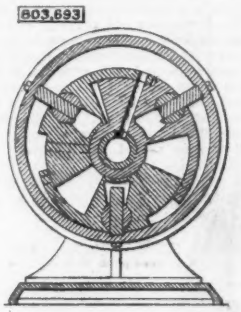
803,671



803,693. ROTARY ENGINE, *W. M. Hoffman, Buffalo, N.Y.—Filed March 25th*, 1905.

This invention is interesting as a very ingenious development of the old elliptical gear rotary engine, in which two pistons con-

803,693



tinually ran away from, and overtook each other alternately. The action will be readily understood from the drawing. There are eight claims.

803,902. TAR MACADAM AND METHOD OF PREPARING SAME, *E. P. Hooley, Nottingham, England, assignor to Tarmac, Limited, Spring Vale, England. Filed November 3rd*, 1902.

This patent covers the construction of an apparatus used for making the now well-known "Tarmac." This is intended to deal with slag, not with stone. The process consists in mixing coating material with newly-solidified hot slag that is to be coated, the

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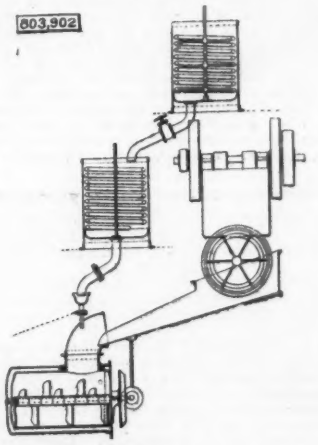
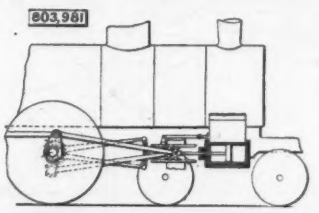


coating material being at a temperature of about 212 deg. Fah. previous to mixing, which temperature is substantially maintained throughout the process. In the drawing are shown two steam-heated tar tanks, the slag-breaking machine, the screen, and a portion of the front end of the mixer. There are eight claims.

803,981. COMPOUND LOCOMOTIVE, *F. W. A. von Borries, Hanover, Germany, assignor of two-thirds to T. W. Worsdell, Stonycroft, Arnside, England, and H. R. Lapage, Surbiton, England.—Filed February 3rd*, 1897.

There are two claims to this specification, the first of which appears sufficiently to describe the invention. It runs as follows:—In four-cylinder compound locomotives, the combination with a crank axle and a steam generator, of one high-pressure and one low-pressure cylinder and reciprocating pistons in each of the cylinders and cranks on the axle, including an angle differing somewhat from 180 deg., all arranged on each side of the engine, and

803,981



operating connections of the cranks with the pistons, each crank on either side of the engine being arranged at right angles relatively to the corresponding crank of the opposite side of the engine, a steam-distributing device between each high-pressure and the corresponding low-pressure cylinder, and means for producing a reciprocating movement of the steam-distributing device, steam passages, and overlapping means on each steam-distributing device, the laps for each high-pressure cylinder being larger than those for each low-pressure cylinder.

A MACHINE to facilitate the construction of concrete walls by doing away with the large amount of lumber usually required for forms has recently been invented and successfully operated in Youngstown, Ohio. It is claimed for the machine that by using different patterns to the pallates any desired effect can be produced, and by the use of ordinary scaffolding for the workmen to stand upon there is no limit to the height that the wall can be built, pointing and finishing the outside as the work advances, and any system of reinforcement can be used without extra labour or expense, or the wall can be built of solid concrete. The thickness of the wall can be kept perfectly uniform, and the gauge set to any desired measure in an instant.

HIGH-SPEED OUTFLOW OF STEAM AND GASES.

By ROBERT H. SMITH.

No. I.

A GREAT deal of mystery has always enshrouded the subject of the rapid outflow of vapours and gases from high-pressure vessels. If it be of importance to understand quantitatively the commonest physical actions occurring every minute in most classes of industrial plant, this subject deserves close study, and it has received very prolonged attention from all classes of engineering students, both those devoting themselves to theoretical science and those content to observe with their eyes alone what occurs in their machines. The safety valve is for ever lifting and letting steam blow off; at the exhaust of every stroke of each steam, or gas, or oil engine there is rapid and violent outrush of steam or gas; each time the admission valve opens there is violent inrush of steam; in air-compressors, fans, and blowers, there is at least rapid flow of the air through ports and pipes, and past valves and their too tortuous passages and casings. But it is in connection with steam turbines that interest has been recently concentrated upon the subject. The essence of the action of a turbine lies in a double process; (1) the conversion of "pressure" or "resilient" energy into kinetic energy, and then (2) the spending of this kinetic energy in driving the blade-wheel of the turbine. Here it is of supreme importance to develop as much kinetic energy as can be extracted from the resilience of each pound-second of the steam used, and also to obtain this kinetic energy in the form of as nearly perfectly *smooth* flow as possible, because all, or nearly all, the streamlet velocities appearing in eddy-form or spraying, or the clashing and twisting of intermingling stream lines, go as waste. Such clashing and whirling go a little way towards maintaining higher pressure than would exist in the fluid without them; but the small increment of pressure due to them is irregularly distributed throughout the space and pulsates irregularly in time, and cannot be turned to useful effect for driving purposes. One of those charming "assumptions" invented for the ease and comfort of mathematical physicists and readers of British Association papers is that such agitatory energy is converted to heat, and thus recovered as resilient energy; and the term "wire drawing," which is a phrase honestly used in the workshops for loss of pressure by high-speed friction, has even been appropriated to describe euphemistically this recovery of pressure and temperature and resilience. Now it is probably quite true that *eventually* all, or most of this energy of agitation and eddy is rubbed and smothered down to heat and similar forms of energy, but this may be accomplished half-an-hour, or a minute, or a few seconds after the fluid has finished its useful work and left the working machine, and is, therefore, entirely useless for practical purposes. The admission period of an engine running at 360 revolutions per minute, lasts for something like from ·02 to ·04 of one second, so that if the process of smothering the energy of whirling and clashing streamlets into heat occupies more than, say, the one-twentieth of a second, it cannot have any technical utility. Again, steam passes through a turbine at a speed of something like 1000ft. per second. The engineer who wishes to use fluids at high speed efficiently must therefore know how to guide them along smooth paths. The avoidance of all irregularity of path or motion is of a degree of importance second only to that of obtaining as much motion, *i.e.*, kinetic energy, as is possible.

There is no subject on which designers of such machines have been more careless. The common idea is that with getting the fluid on to the running blades without shock, the whole duty of the designer has been faithfully accomplished. The subject is, no doubt, a very difficult one, but this is a bad excuse for leaving it alone and giving your working fluids free play to run their own wild courses. True guidance is of the essence of all efficient mechanism, and the way to guide and govern these high-speed flows of expansive fluid can only be learnt by careful study of how pressure and cross-section are co-related from point to point along the axis of a smooth, unagitated stream, and of the causes that set up eddies and all deviations from smoothness.

The present articles develop in tables and diagrams the law connecting variation of velocity and of section with the gradual fall of pressure along the axial line of the flow. Without a down grade of pressure, there is, of course, no generation of kinetic energy. The difference of pressure at two separate sections is the cause and the measure of the rate at which the fluid lying momentarily between these sections is accelerated. In passing from the one to the other section each unit of fluid loses a definite quantity of resilient energy, and gains a corresponding amount of kinetic energy which determines its velocity. For each pressure reached on the down-grade of pressure, each such pressure being reached at a section in fixed position so long as the flow is steady, there is also reached a corresponding density, the pressure and density going down together. Low density means high specific volume, and large volume at a specified velocity means correspondingly large section. The cross-section, in fact, equals the volumetric flow per second divided by the linear velocity per second. Thus from the curve co-relating pressure and specific volume may be calculated, for each pressure, the work spent in producing kinetic energy, from which the linear velocity is found, and using this last as divisor of the specific volume the cross-sectional area is reckoned.

The linear velocity so gained has very often been calculated; the resulting cross-section not often until quite recently. The cross-section, however, for the purpose of designing efficient guiding channels, is an essential and fundamental element in the problem. The result altogether depends on the character of the expansion curve co-ordinating pressure and volume. This curve is different according to the condition of the walls and surroundings of the channel. If the flow were through a passage kept much hotter than the flowing vapour or gas, the heat received by the expanding fluid would hold up the curve, so that greater specific volume and correspondingly greater cross-section would be reached at each given pressure stage. If the fluid flow through a channel much colder than itself, the heat conducted from the fluid to its colder surroundings lowers the curve and diminishes the cross-section at which each pressure is reached. Loss and waste of internal energy in other ways than by conduction of heat—for instance, by frictional and viscous rubbing or by minute eddy making—lowers the curve in an exactly similar manner. Most of these curves are accurately enough expressed by the law $p v^i$ = constant; but the index i depends wholly upon how much heat or other energy is going inwards or outwards per second through the walls or is being otherwise dissipated. If α be the index for adiabatic expansion, it is shown in the writer's book on "Steam Engine Economy" that the index for any non-adiabatic curve is $i = \alpha + \frac{H}{h p v'}$, where H means the time-rate of heat extraction through the walls, p the pressure, v' the time-rate of volumetric expansion, and h the heat conduction required to produce unit rise of pressure when the volume remains unchanged.

With any curve of this sort, a proper index i being found for it, the work available for generating kinetic energy of flow while the pressure falls from p_1 to any pressure p was shown by Rankine and others to be equal to—

Work for kinetic energy per unit weight

$$= p_1 v_1 \frac{i}{i-1} \left\{ 1 - \left(\frac{p}{p_1}\right)^{\frac{i-1}{i}} \right\}.$$

If it all be actually spent in producing smooth regular flow of linear velocity S, and the initial velocity at the pressure p_1 be zero, or negligibly small, we equate this to $S^2/2g$. Using feet and seconds and 8 for $\sqrt{2g}$, and calling by r the ratio of pressure fall p/p_1, we find the acquired velocity to be—

$$S = 8 \sqrt{p_1 v_1} \sqrt{\frac{i}{i-1}} \sqrt{1 - r^{\frac{i-1}{i}}}.$$

Now the specific volume reached along with pressure p is $v = v_1 r^{-\frac{1}{i}}$, where v_1 is the initial specific volume at pressure p_1. Dividing this v by the speed S, there is obtained the

Cross-Section per unit weight flowing per second

$$= A = \frac{v}{S} = \frac{1}{8} \sqrt{\frac{v_1}{p_1}} \sqrt{\frac{i-1}{i}} \div \left\{ r^{\frac{1}{i}} \sqrt{1 - r^{\frac{i-1}{i}}} \right\}.$$

The same cross-section reckoned per unit *initial volume* is measured by the same formula with $\frac{1}{\sqrt{p_1 v_1}}$ substituted for $\sqrt{\frac{v_1}{p_1}}$.

Thus it is seen, in the first place, that the sections required per pound-second flow depend largely upon the point of the $p v$ curve from which the flow starts—that is, upon the initial pressure and density. Drawing a line from the origin of the $p v$ diagram to this starting point, $\frac{v_1}{p_1}$ is the slope of this line from the vertical, and all the A's at all the subsequent pressures are proportional to the square root of this initial slope. If the fluid be a gas the position of the curve and of the initial point on the diagram depends, of course, on the initial temperature. If the equation to the gas be $p v = C\tau$, then $\sqrt{\frac{v_1}{p_1}} = \frac{\sqrt{C\tau_1}}{p_1}$; so that all the A's per pound-second of the flow are directly proportional to the square root of the initial absolute temperature and inversely to the initial pressure. On the other hand these same A's measured per unit volume per second at initial pressure and temperature vary inversely as $\sqrt{C\tau_1}$. If the fluid be dry saturated steam, then, as the saturated steam curve has the equation $p v^{\frac{100}{94}}$ = constant, $\sqrt{\frac{v_1}{p_1}}$ and all the A's per pound-second of the flow are inversely proportional to the 0·97th power of the initial pressure—that is, they vary not quite so rapidly as the reciprocal of this pressure. Reckoned per cubic foot per second at the initial pressure, the sections are inversely proportional to the ·03 power of the initial pressure; *i.e.*, they vary very little with the initial pressure. If it be wet steam with dryness x, then the A's are less than with dry steam in the ratio $\sqrt{x}$.

In the second place the cross-sectional areas A depend upon the index i.

In the numerator the factor $\sqrt{\frac{i-1}{i}}$ becomes larger, and in the divisor both factors also become larger, so that the whole becomes smaller with increase of i. Table I., given below, illustrates fully in what manner and in what proportion this decrease occurs. The larger index means that the $p v$ curve drops more rapidly, and this decrease of cross-sectional area takes place because the specific volumes reached at each given pressure drop decrease in still greater proportion than do the generated velocities.

TABLE I.

Cross sections per 1 lb. second flow divided by $\sqrt{\frac{v_1}{2g p_1}}$ at various ratios of pressure fall r.

Expansion index i	1·0	1·05	1·1	1·15	1·2	1·3	1·4	1·5
Ratio of pressure fall r ...	Section $\div \sqrt{\frac{v_1}{2g p_1}}$							
·95	4·668	4·656	4·645	4·635	4·625	4·608	4·593	4·588
·9	3·422	3·414	3·405	3·397	3·389	3·372	3·355	3·326
·7	2·382	2·357	2·335	2·318	2·292	2·251	2·218	2·183
·6	2·320	2·283	2·254	2·221	2·190	2·135	2·090	2·050
Minimum	**2·330**	**2·286**	**2·250**	**2·216**	**2·182**	**2·120**	**2·065**	**2·017**
r ... ... =	*·605*	*·595*	*·585*	*·574*	*·564*	*·546*	*·528*	*·512*
·5	2·396	2·340	2·290	2·245	2·203	2·120	2·068	2·017
·3	3·052	2·910	2·799	2·699	2·669	2·456	2·337	2·240
·1	6·758	6·130	5·637	5·256	4·912	4·390	3·975	3·658
·05	11·65	10·37	9·39	8·60	7·90	6·81	5·98	5·35

For each kind of vapour or gas starting from a given initial condition, and expanding under given thermal conditions fixing a constant index i, the measure of A given above does not change in its numerator along the path of the flow, but only in its divisor, and here changes only with $r = p/p_1$. That is, the variation of the section along the path depends solely upon the drop of pressure—or, rather, solely upon the ratio of this drop. Thus the ratio in which the section varies can be plotted out in terms of the ratio in which the pressure falls, and this plotting will stand good for all initial pressures. It would be improper to say that it stands good for all *initial sections*, because there exists *no initial section* to base the comparison upon. The initial section is non-existent, because the calculation starts the pressure from where the velocity is practically zero, and where therefore one cannot speak of there being any flow or any cross-section of the flow. But if one chooses to make the comparison, taking as base the section at any standard ratio of drop of pressure, as $\frac{9}{10}$ of the initial pressure, for instance, or $\frac{6}{10}$ or $\frac{1}{2}$, then one can say that the above plotting holds good for any base section. It will appear that as the pressure goes down the section decreases to a minimum and then increases again. The ratio of pressure at which the minimum occurs depends on the index i of the expansion curve, varying from slightly below $\frac{6}{10}$ the initial pressure to a little above $\frac{5}{10}$ of the same. The minimum section is, of course, a very important item in the design of guiding channels for such flows, and therefore it is chosen below as the base with which to compare the other sections at other points in the length of the channel. The rate at which the section A varies with the ratio r of the progressive pressure-fall, or the "r-gradient of A," can, by an easy mathematical process, be shown to be proportional to a certain number of factors which remain throughout positively greater than zero, and, at the same time also proportional to

$$-\left(1 - \frac{i+1}{2} r^{\frac{i-1}{i}}\right).$$

The index i might be, and probably is, less than 1 when there is violent heating of the outflowing jet, as in the case of the injection of a steam or air-jet into a metallurgical furnace or into a gas-producer, or even into an ordinary boiler furnace. But in steam turbines and in the exhausts of steam and gas and oil engines, and in escape of steam by safety valves, the index is always greater than 1. In such cases $\frac{i+1}{2}$ is greater than 1, and the index $\frac{i-1}{i}$ is a small positive fraction. For example, taking $i = 1{\cdot}2$, then $\frac{i+1}{2} = 1{\cdot}1$ and $\frac{i-1}{i} = \frac{1}{6}$.

Thus, near the beginning of the flow when r is not much less than 1, $\frac{i+1}{2} r^{\frac{i-1}{i}}$ is greater than unity, and the above "r-gradient of A" is positive, which means that A goes down with the pressure. But when the pressure has fallen very low, so that r is very small, it is evident that the quantity inside the brackets is positive, and the r-gradient of A negative, which means that A increases as the pressure falls further. Thus A must reach a

minimum between these two stages of the expansion, where the gradient of A is zero. This limit is given by the ratio of pressure fall—

$$r = \left(\frac{2}{i+1}\right)^{\frac{i}{i-1}}.$$

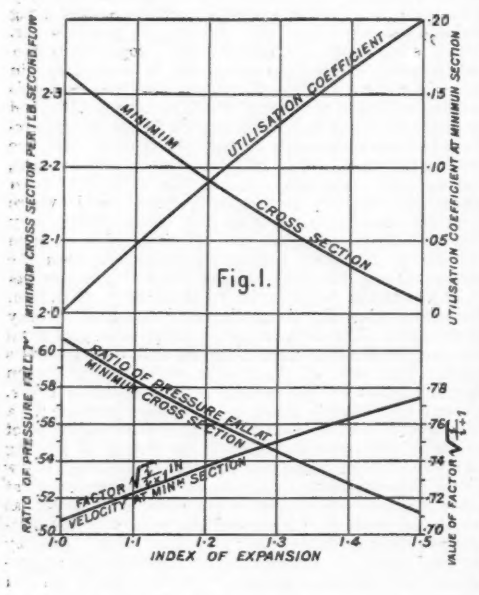
The writer has calculated this ratio for a range of indices between 1 and 1½, and the results are found in the second column of Table II., and also plotted as a curve in the diagram, Fig. 1.

Table II.

Expansion index i.	Ratio of pressure fall at minimum section, $p/p^1 = r$.	Minimum cross-section per 1 lb. second flow, $A_{min} \sqrt{\frac{2gp_1}{v_1}}$	Velocity through minimum cross-section, $S A_{min} \div \sqrt{2gp_1v_1}$.	Kinetic utilisation at minimum cross-section.
1·00	·6055	2·330	·708	0
1·05	·5952	2·290	·716	1/41
1·1	·5848	2·252	·724	1/21
1·15	·5743	2·216	·731	3/43
1·2	·5645	2·183	·738	1/11
1·3	·5458	2·120	·752	3/23
1·4	·5282	2·065	·764	1/6
1·5	·5120	2·017	·775	1/5

For indices only little greater than 1, the pressure ratio at the minimum section is just under 6/10. When the index is as much as 1½, which means a curve steeper than the dry gas adiabatic, this pressure ratio is just over ½. The curve in Fig. 1 is a very flat one, and, if it be taken a straight line, its mean equation is $r = \cdot 792 - \cdot 188\, i$.

This limiting value of r must be inserted in the formula for A in order to calculate the sizes of the minimum cross-sections. The result is a repulsively complex formula which very few of the readers of The Engineer would feel inclination to apply to special cases. But as knowledge of these sections is of technical importance, especially in the design of efficient turbines, the writer has undertaken and carried out this repulsive calculation for the complete range of indices. The numerical values are given in the third column of Table II., and are also plotted



as a curve in Fig. 1. The repulsive formula itself is Minimum Cross-Section per 1 lb. second flow

$$A_{min} = \sqrt{\frac{v_1}{2gp_1}}\left(i+1\right)^{\frac{i+1}{2(i-1)}} \div \left(2^{\frac{1}{i-1}}\sqrt{i}\right)$$

This curve is not so flat as the last mentioned; but its maximum deviation from a mean straight line is only ¼ per cent. the mean value. Thus in place of the above cumbrous formula there may be used without any important error the very simple equation—

$$A_{min} = \sqrt{\frac{v_1}{2gp_1}}\,(2\cdot 941 - \cdot 624\, i)$$

In the table and in the diagram the first factor $\sqrt{\frac{v_1}{2gp_1}}$ is omitted; its value is special to each particular case.

To calculate the minimum section, or that of the narrow neck of the nozzle for a high-speed outflow jet, find $\sqrt{\frac{v_1}{2gp_1}}$ for the special conditions of the particular case, and multiply by the factor in the table, or the height of the curve in the diagram, for the index i proper to these special conditions. It will be seen that for each particular initial condition given by v_1 and p_1, the section of the narrow neck decreases as the index i varies from 1 towards 1½, that is as the expansion curve becomes steeper, or the external conditions surrounding the jet become less favourable to the jet receiving heat by conduction through the walls of its channel.

To calculate the velocity of outflow through this narrowest section, one must insert the above limit value of r in the formula for the velocity. The result has a much more cheerful algebraic appearance than in the case of the sectional area. Nevertheless, the value of the factor changing with the index, namely, $\sqrt{\frac{i}{i+1}}$, is tabulated in the fourth column of Table II., and is plotted as a third curve in Fig. 1, so that it may be read off at sight without trouble for any special index. The formula is:—

Velocity through Minimum Section

$$S \text{ at } A_{min} = \sqrt{2gp_1v_1}\cdot\sqrt{\frac{i}{i+1}}.$$

This velocity increases slowly with the index, only in the ratio 1 to 1·1 through the whole range of i from 1 to 1½. This curve also being very flat, a straight line may be taken as substitute, giving

$$\text{Speed at } A_{min} = \sqrt{2gp_1v_1}\,(\cdot 577 + \cdot 133i).$$

Here for dry saturated steam $\sqrt{2gp_1v_1}$ varies little below and above 2000ft. per second.

NOTES ON BELT AND ROPE DRIVES.

By James Stormonth.

In order to have the least trouble with belts and ropes it is necessary to give attention to other points than merely those relating only to the classes and makes, important as these are. The most efficient driving of belts is obtained when the driving and driven pulleys are of approximately equal diameter—when the crowning is slight, when the resistance is continuous and not intermittent, when the speed is moderate, say, up to 2000ft. per minute for 4ft. diameter pulleys, and when the load is moderate per inch of width of the belt.

When the driving and driven pulleys are equal in diameter, and have equal crowning, the belts stretch in the centre somewhat in the proportion—the length of the belt in the middle of its breadth is to the middle diameter of the pulleys as the length of the edge of the belt is to the diameter of the edges of the pulleys. From this it follows that when the pulleys are unequal in diameter the crowning of the smaller pulley should be proportionately less than that of the larger. Slight crowning, again, involves accurate aligning with such classes of machinery as centrifugal pumps and dynamos. Indeed, accurate aligning is necessary in ordinary cases, for should the belt be pulling at the centre, and one edge of the small pulley, the edge of the belt drives the spindle faster than the middle of the belt does, and flying-off may result. To prevent this flying off some makers give extra rounding to small pulleys. This limits their effective width. Thin belts, if sufficient for their work, lessen the wear and tear incidental to such drives.

When a small pulley drives a larger as in the case of some motors, the edges of the pulley—unless the crowning is properly proportioned—drive slower than the centre of the pulley, and the belt tends to wear in the centre. It is sometimes necessary, especially in the case of main driving belts, to have two belts and two pulleys. This lessens the size of the pulleys and allows the use of smaller and handier belts. A belt, for instance, 30in. in breadth is quite heavy enough to handle. With such drives it is advisable to have belts of the same class and in similar condition. If one of the belts is replaced by a new belt, the slip of the new one being greater than that of the old throws the driving practically on the old belt, with the result that the old belt deteriorates rapidly. Such belts should, therefore, be of the same class, and, if possible, in the same condition. Another method of compounding is to have one belt running on the top of another. The outside of any belt as it passes the pulleys run faster than the inside. Unless the belt accommodates itself to this difference of speed by stretching, or otherwise, severe stresses are set up, tending in the case of rubber belts to splitting of the plies, and in the case of woven belts to cracking or disintegration. Should a belt be insufficient for its work, and another be placed above it, the thickness of the belt is increased, while the outer one is free to travel round the inner one. If each of the belts is ⅜in. in thickness, the total belt, as it were, is ¾in. thick, while the outer belt, being free to travel round the inner, the stresses which would ensue in the case of a solid belt ¾in. thick are avoided. Should the inner and original belt only require a few more pounds per inch of width to give effective pulling, and moderately easy running, or should the inner belt only require the tension on the slack side to be slightly increased, then the outer belt may do little more than run round with the inner belt. But if the outer belt must needs exert a pull of 30 lb. to 50 lb. per inch of width, considerable friction between the two parts will result. In the case of a single belt, a certain amount of friction takes place as the belt leaves the pulley, giving rise to the slip. An outer belt, at the point of slip, under a fair amount of tension, exercises an amount of friction injurious to both belts. At a place well known to the writer, a number of driving pulleys, for want of room, drove each two separate pulleys. The inner belt was placed on a pair—the driving and one driven pulley—the outer belt enveloped these two and the remaining pulley. The outer belt ran approximately in the figure of a triangle, the driving pulley being at one angle and the driven at the other two. The result was a great amount of wear and tear on the outer surface of the inner belt and the inner surface of the outer belt. As the inner belt was riveted the heads of the rivets affected injuriously the inner surface of the outer belt. This is to be expected, particularly when the rivets reached the point of slip, where the belt leaves the pulleys. The double belts increased the ratio of damage when the belts slid off the pulleys at any time. Alterations and extensions being made, the arrangement was discarded.

Another virtual method of compounding occurs when two engines drive on to one shaft. The varying impulses, especially with gas engines, frequently prove a source of trouble both to belts and shaft.

Here it may be advisable to refer to a certain amount of confusion in the use of the terms slip and slipping. Slip is the action of a belt due to its compression and extension. It results in the driven pulley running at a slightly slower speed than the speed calculated from the pulley diameters. Slipping is the term used for the action of a belt when it travels round a pulley without turning it. The similarity to the term slip is misleading, and the writer suggests the use of the word sliding for slipping. Sliding, as is well enough known, frequently results from the belt being insufficient for its load, or from its being too slack. It may result from water getting to the belt. Rubber belts are more easily affected by water in this way than other classes of belts. When a rubber belt is too difficult to knock off by hand while the driving shaft is in motion, a jet of water directed between the belt and pulley will slide it off. To reverse the operation, sawdust sprinkled on the belt will absorb the water. Rosin causes a belt to grip, though its use is frequently prohibited as it prevents the belts leaving the pulleys freely, and tends to tear them. Fibrous belts are not so easily affected by water as to make them slide. The fibres absorb the water, and the belts become tighter. Belts of the "balata" class are the most suitable for situations exposed to water.

While it is not always expedient to replace pulleys on which belts are inclined to slide with larger ones, it is noteworthy that belts requiring frequent tightening are severe on the bushes of the shaft. It is always well to have pulleys as large as is consistent with the conditions.

Whether a belt slides or not under shock depends on the circumstances of the case. In a case of shock a measure of relief is given by a slight extension of the driving side of the belt. In the action produced by irregular turning effort in a crank shaft a belt will pulsate accordingly. The writer has often noticed the irregular action of gear wheels, between which and the engine crankshaft were two drives, one a belt drive and the other a rope drive. Yet these drives did not absorb, unless to a certain extent, the variable impulses. In the case of steam engines driving industrial machines, irregular driving effort will be transmitted in spite of belts, and, it may be added, in spite of appearances to the contrary.

This irregular effort may sometimes be due to the want of knowledge on the part of the designer either of the subject or of its importance. It may also be due to the designer not knowing the limits of speed and power through which the engine has to work, and making it "big enough." In the writer's opinion this ignorance is in certain directions a pronounced evil.

A case of irregular action due to a faulty slide valve came under the writer's notice recently, and as it illustrates how belts respond to varying impulses, he ventures to give an account of it. An engine drives four paper-cutting machines. The revolving knives which cut the paper into lengths were belt driven. Four belts intervened between the engine and each of the revolving knives. Two of the machines that had formerly done satisfactory work began to fail in accuracy of cutting. From cutting the sheets with a variation of $\frac{1}{16}$in. in length they cut with ¼in. of variation and even more. Many facts might possibly have caused the variation—deceleration of the speed of the knife at the time of cutting—slackness of gear, and so on. The engine ran easily and quietly about eighty revolutions per minute. A clue was obtained from the fact that certain lengths of sheet were cut fairly exact, while shorter ones varied. Reasoning from this, it was considered that the engine speed being uniform as to the number of revolutions per minute, sheets cut during one revolution of the engine would be uniform. And if the engine varied during one stroke or one revolution, sheets cut during a part of a revolution might vary if one sheet embraced, so to say, two points of acceleration, and another embraced two points of deceleration. A slight waviness on the tight side of the driving belt, and a slight vertical movement of the governor suggested irregular movement. Another drive was substituted, and the trouble disappeared. The slide valve was found in bad order.

Such variations, however, are not so palpable in their wearing effects on belts as those due to severe irregular stresses as may be caused by ungeared pumps.

With regard to the pull per inch of width of a belt, a moderate pull, as 25 lb., is conducive to longevity. For heavy driving, where pulleys have to be kept within reasonable limits, main belts will transmit at the rate of 90 lb. per inch of width rated per indicated horse-power of the engine.

The advantage of having the driving sides of belts and ropes underneath is well known, though it is not always practicable. But it is well to note that with such drives as fans or centrifugal pumps the loss of efficiency due to the upper side being the driving side is enhanced. Owing to the inertia of the belt, and partly to the centrifugal effect increasing the resistance to bending as the belt passes round the smaller pulley, daylight can often be seen between part of the arc of contact and the belt. This shortens the length of the effective arc of contact.

Rope drives, like belts, do best on equal pulleys if the grooves are uniformly cut. One rope may be deeper in its grooves than another, and yet the ropes may pull uniformly. Equal pulleys are, however, rather the exception than the rule. The endeavour, therefore, should be to have the ropes pulling equally. This implies the avoidance of mixed drives of new and old ropes. The new ropes do not sink so far into the grooves, so that the driving is unequal and the ropes mutually destroy one another. With ropes, as with men, the weaker, figuratively speaking, go to the wall. When new ropes are required, say, in a drive of twelve, eight or ten, at least, should be used, if not the whole twelve. When one or two new ropes are placed the old ones overrun them, and the slack of the new ones is thrown

to the under side, if the under side is the driving side. The tension on the new ropes increases the stretch. When the rope race is shallow the ropes are quickly damaged. If ropes are put on fairly tight they may run without revolving, say, with two new ropes in a two-rope drive. In such a case a V shape is acquired, which is inimical to re-splicing, but, in the writer's opinion, gives the least trouble and best results. As the V contact increases, the rope is apparently pulling at different diameters, and this eventually disintegrates the ropes, though the ropes, except at the V contact, are unworn. When a rope is overrun by a pulley through the other ropes driving the pulley more quickly, or if a rope is running the pulley faster than the others through its depth in the groove lessening the diameter at which it pulls or attempts to pull, the rope will incline to revolve. A rope placed in a groove and pulled by hand will revolve, owing to the spiral lay of the strands. Necessarily an overrun or overrunning rope wears rapidly.

A moderate amount of belt lubricant—graphite soap and treacle is one—is useful occasionally, and assists the ropes to adjust themselves by helping a thin rope to slide. Too much will make or may make the ropes slide.

SOME SURVEYING INSTRUMENTS.

By A SWISS ENGINEER.

No. II.*

IT is well known how very difficult it is to carry out measurements in tunnel construction; difficulties of light, narrow space, timbering works going on, noise, dangers, &c. All these make measuring operations arduous and tedious.

First of all, the starting points have to be truly established, and then a number of points have to be set out exactly, so as to give a sufficient number from which to work, so as to avoid—or reduce to a minimum—unnecessary excavations and consequent superfluous masonry, both of which mean considerable waste of money, a waste which cannot entirely be avoided, but which assumes much greater proportions than is generally supposed. Taking the case of a great tunnel in rocky material, there is, as a rule, a bottom heading, and above it either a top slit or chimney for driving the top heading.

Setting the instrument on the known point a, Fig. 7,

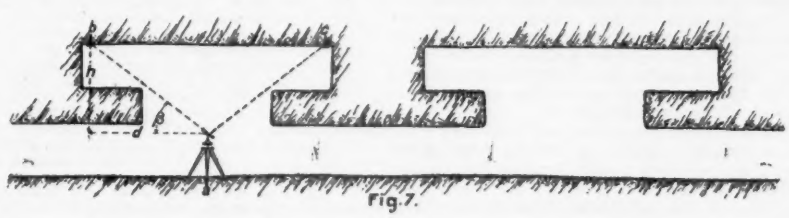


Fig. 7.

on the axis of the tunnel, and centering it to the axis, it will at once be seen that sighting the telescope to the two points of top heading b and c, the height of these points $= d \tan \beta$, thus at the same time the direction as well as the elevation of these points is obtained.

The height of b above the instrument is in this case $h = d \tan \beta + 0{\cdot}50 = 10 \times 0{\cdot}20 + 0{\cdot}5 = 2{\cdot}50$ m., or the elevation $= 708{\cdot}00$ m. above sea level.

In obtaining the cross-section of a tunnel, Fig. 9, we have a = the point of axis on which the instrument is set; l = distance from the instrument to the section to be taken; a, b_1, b_2 = the vertical plan in the tunnel axis; c_2 = a chosen sectional point; a, b_1, c_1 = the horizontal plan through the horizontal axis of the instrument; we get $b_1, c_1 = l \tan \alpha$, $\tan \alpha$ being read on the instrument, and $a_1, c_1 = l \sec \alpha$; further, $h = l \sec \alpha \tan \beta$.

Supposing $l = 20$ m., and the corresponding readings

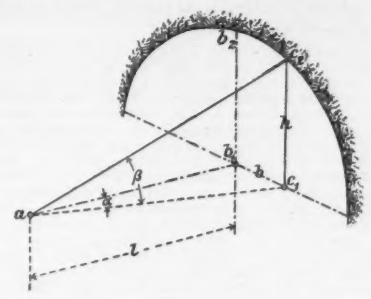


Fig. 9

on the instrument for $\tan \alpha = 0{\cdot}232$, for $\sec \alpha = 1{\cdot}027$, and $\tan \beta = 0{\cdot}125$, we get—

$$b = 20 \times 0{\cdot}232 = 4{\cdot}64 \text{ m.};$$
$$a, c_1 = 20 \times 1{\cdot}027 = 20{\cdot}54 \text{ m.};$$
$$h = 20{\cdot}54 \times 0{\cdot}125 = 2{\cdot}57 \text{ m.}$$

The point c_2 is thus determined, and we are in this way able to continue up to a sufficient number of points. It is easily seen that, choosing l at a round figure like the above, we have very easy calculations to make, in many cases being able to make them mentally. The clear marking of the points to be sighted to is, in the tunnels, a matter of no small practical difficulty. As an outcome of many trial experiments, one of the best methods found has been the following:—

A square plate—Fig. 10—has a bright lamp fixed to it, and has an opening in the middle to let the lamp light through. The plate is fixed on to a rod, and the point a held on to the points wanted. The lamp throws its light on to the space behind the plate, thus clearly marking out the holes at a and b.

Table of the Section Points of Ring No. 9—vide Fig. 11—of the Siding Part, Simplon Tunnel.

Number of point.	Elevation above sea level.	Horizontal distance. Tan α. Left.	Tan α. Right.	Distance b. Left.	Distance b. Right.	Sec. α.	Vertical distance. Tan α + = above − = below horizon.	Rod or lamp.	Height $\pm h$.
1	703·48	0·258		5·16		1·037	− 0·056		− 1·16
2	704·66	0·258		5·16		1·037	+ 0·001		+ 0·02
3	705·80	0·254		5·08		1·036	+ 0·056		+ 1·16
4	706·22	0·299		4·98		1·044	+ 0·076		+ 1·58
5	707·21	0·232		4·64		1·027	+ 0·125		+ 2·57
6	707·79	0·217		4·34		1·023	+ 0·022	+ 2·70	+ 3·15
7	708·64	0·189		3·78		1·018		+ 4·00	+ 4·03
8	709·20	0·163		3·26		1·014		+ 4·56	+ 4·56
9	709·50	0·141		2·82		1·010	+ 0·232	+ 17 cm.	+ 4·86
10	709·92	0·099		1·98		1·005	+ 0·260	+ 5 cm.	+ 5·28
24	703·77		0·259		5·18	1·038	− 0·042		− 0·87

$l = 20$ m. Height of instrument = 704·64.
The instrument placed 2·60 m. to the right of tunnel axis 1.

Given d measured = 10 m. and $\tan \beta = 0{\cdot}320$—reading on the instrument—the following equation is obtained—

$$h = 10 \times 0{\cdot}320 = 3{\cdot}20 \text{ m.}$$

If d cannot be measured in a direct way, a levelling rod about 2 m. long is placed at b, Fig. 8, and sights are taken

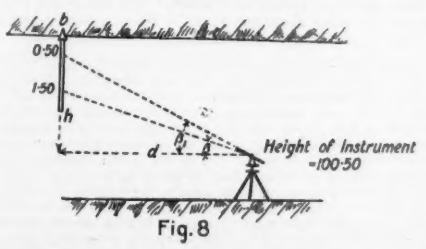


Fig. 8

first to 1·50, then to 0·50. Making the readings $\tan \beta_1$ and $\beta = 0{\cdot}20$ and $0{\cdot}10$, we get the distance d from the equation—

$$\frac{1{\cdot}50 - 0{\cdot}50}{d} = \frac{0{\cdot}20 - 0{\cdot}10}{1}, \text{ and thus } d = \frac{1{\cdot}00}{0{\cdot}10} = 10 \text{ m.}$$

The instrument is sighted to the holes at a, and if these be covered up by some projecting point, to the holes at b.

The taking of the twenty-four section points, according to Fig. 11, took 80 minutes, and according to the tunnel engineers the actual ordinary work done in five hours

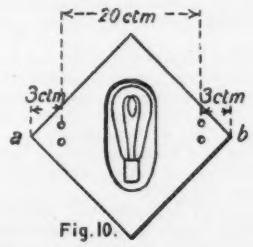


Fig. 10.

was the taking of twenty tunnel sections with thirteen points each.

Apparatus for setting out curves.—In order to simplify the operation of setting out curves by means of angles the additional horizontal arc is of length $\frac{r}{2}$ (*vide* Fig. 2 *ante*) and divided in ten divisions with ten subdivisions each.

The length of this arc-piece corresponds to a value of $\frac{180^\circ}{2r} = 28^\circ\ 39'$.

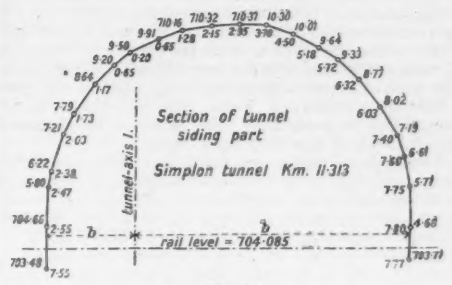


Fig. 11

In Fig. 12 we have:—
r = the radius of the arc-piece of the instrument.
A = length of piece of curve, the end of which it is wanted to be set out.
R = radius of curve.
a = the reading on the instrument arc-piece.
2γ = centre angle corresponding to A.

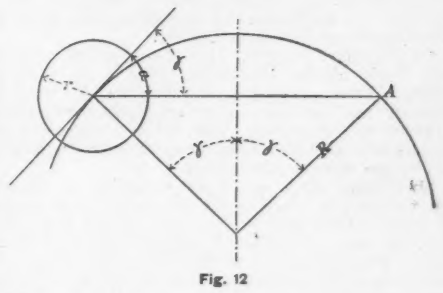


Fig. 12

We have the relation –

$$\frac{a}{r} = \frac{A}{R},\ r = 1,\ A = a \cdot R, \text{ from which } a = \frac{A}{R}$$
$$\text{and } R = \frac{A}{a}.$$

Having, for instance, R = 200 m., and wanting to set

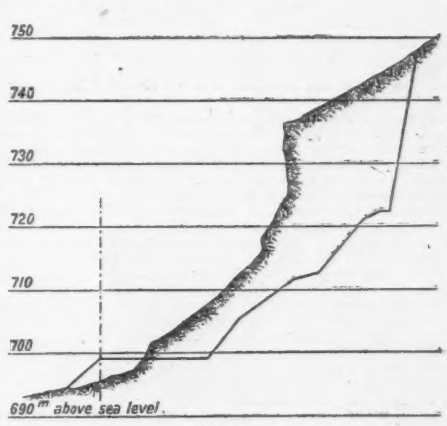
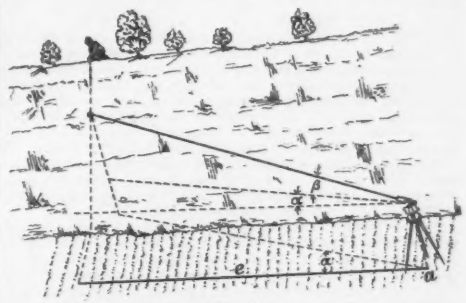


Fig. 13

out a point of curve at 20 m. distance from the instrument, we set it right on the tangent and the vernier at zero, and have to make the following calculation:—The length of instrument arc corresponding to 20 m. of the curve is $a = \frac{A}{R} = \frac{20}{200} = 0{\cdot}1$. The vernier set at 0·10 of the arc division gives the direction in which to



F . 14

measure out the 20 m. to get the point A of the curve.

Supposing the length of curve A to be wanted, we read the corresponding length on the instrument arc and get $A = a \cdot R = 0{\cdot}10 \times 200 = 20$ m., or supposing the radius of curve has to be determined, we get for a length of curve = 20 m. the arc reading = 0·10, and have $R = \frac{A}{a} = \frac{20}{0{\cdot}10} = 200$ m. According to these examples we see that in a great many cases we are able to do the

* No. I. appeared December 15th.

calculations mentally, and the whole operation is, at all events, extremely simple.

To measure the deep cutting on the Brigue side of the Simplon Tunnel the difficult cross-sectioning was done by means of the Meyer and Weismann tacheometer. A line was run parallel to the side of the excavation—*vide* Figs. 13 and 14—the points of sections were chosen and marked at right angles on to the upper edge of the excavation. The instrument was set on a suitable point *a* and sighted on to a ball, which was let down from the upper edge in the line of cross-section, and thus this very difficult cross-sectioning was done in a very accurate way and without any great bother of calculation. From one instrument station twenty-five cross-sections were taken in the course of two days, which was very quick work.

Every special instrument demands, of course, a certain time to get used to it, but this tacheometer is very simple in its application and ought to be found a first-class instrument for tunnel construction, as well as on open-air works. The use of the instrument is so simple that if made in a somewhat modified way, any intelligent foreman can be trained to use it, and thus enabled to do the principal part of his work of measuring much quicker than is ordinarily the case, and with sufficient accuracy.

CONFERENCE ON SMOKE ABATEMENT.

No. II.

In our last issue we gave an account of the opening meeting of this Conference at the Royal Horticultural Society's new hall in Westminster, and also of the papers and discussion on "Domestic Smoke Abatement" which followed this on Wednesday, December 13th, under the chairmanship of Sir George Livesey.

On Thursday, December 14th, the subject of "Factory and Trade Smoke Abatement" was dealt with, Sir William Preece occupying the chair on this occasion. The chairman's address and seven papers were disposed of in the short space of an hour, and ample time was thus obtained for the discussion, in which a large number of the visitors and delegates joined.

Sir William Preece opened the proceedings by reading a short address, in which he first compared the atmosphere of London with that of Paris and Berlin, and quoted from the recently published report of the Birmingham Brass Workers' Society to show the greater cleanliness of the air of the latter city. After proving that the black fogs from which London suffered were largely caused by the particles of dust and carbon suspended in the air, a result of the imperfect combustion of coal, Sir William discussed the more practical side of the subject of smoke prevention in the following paragraphs:—

> The presence of carbon particles in the air is a proof of the imperfect combustion of coal in our domestic as well as in our factory fires. If the combustion had been perfect, no solid carbon could be present except as carbonic oxide or carbonic dioxide, which are gases and invisible. Hence the removal of this matter from the air means not only purification of the air but economy of production, for it must increase the efficiency of the furnace. To minimise fog we must, therefore, reduce the number of carbon particles in the air, and this is to be done by improving the methods of combustion.
>
> The proposals to establish a few large power-houses on the river in London to supplant the seventy or eighty scattered generating stations that now exist have one great merit—they will abate the nuisance of smoke and introduce more perfect methods of fuel combustion and so reduce fog, for the cheapening the cost of production of electric energy means the adoption of every known means of economy. Internal combustion engines where producer gas is sucked in and exploded afford other promising fields for the enthusiast. They produce no smoke and discharge no particles, but they are limited at present to small engines and not yet applicable to the great power houses that are now increasing in all industrial areas. It is probable that the greatest sinners are the ordinary domestic grates, the most unscientific and inefficient heat producers in existence. Their consideration does not come within the function of this section, but I cannot resist condemning a system which patriotism, conservatism, or sentiment maintain popular, aided by the abundance and cheapness of coal. The supposed cheerfulness of an open fire is proverbial, and there may be some truth in it, for it certainly aids ventilation. On the other hand, it encourages draughts and causes the distribution of heat to vary immensely in different parts of the room. I have remedied this last defect by having an open fire at one end of the room and a radiator excited by hot water or by electric currents at the other end. The price of electrical energy is falling so rapidly that the electric radiators will soon become a domestic comfort within the reach of all.
>
> There are many well-known smoke-consuming processes. Bituminous coal can be burnt completely so as to emit no smoke. It is only necessary (1) to regulate the air supply, (2) to secure and maintain the proper temperature, (3) to control the escaping gaseous products. Such arrangements are undoubtedly economical. Crossfield and Sons, of Warrington, have saved 1000 tons of coal per week by adopting scientific smoke abatement methods. Newnes and Company, and the Cardiff Railway Company assent that they have saved 25 per cent. of their coal consumption. A firm of brewers in London have saved £3500 per annum, and I can speak from my own experience, that wherever such appliances have been used marked economies have followed. But it must be remembered that chimney, flue, furnace, mechanical stoking air regulation, preparing, elevating, and conveying fuel, water heating all lend their weight to the desired consummation—the complete conversion of the potential energy of coal to the kinetic energy of heat and the total elimination of smoke. The production of smoke is a wasteful and useless barbarism, and I hope this Conference will drive that fact home. There are certain peaceful methods of attaining this goal by gas, oil, and electricity, but we are here to discuss smoke abatement.
>
> The Smoke Abatement Society prides itself on the number of convictions it has obtained under the Act of 1891. It would be much more effective if it recorded the number of firms which have adopted scientific measures and shown their economical results. This would excite emulation—a very potent force in commerce and industry. Law is not so effective as simple common sense. Satisfy people that money can be saved—they will save money. Most people rejoice in doing what they are told they ought not to do; it is the cussedness of human nature.

The first paper taken at this session of the Conference was contributed by Commander W. F. Caborne, C.B., and dealt with "Stoking and Smoke Abatement." The author opened by stating that it might be accepted as an axiom that good stoking is the main factor in the prevention of the emission of smoke from furnaces. In many cases, an expert stoker will obtain better evaporative results from a poor coal than an untrained stoker can obtain from a very good class of coal, and the personal equation in all cases is undoubtedly of paramount importance, whatever the type of furnace and kind of work required from it. The author then gave quotations from the Foreign-office report, issued early in 1905, to show that this view was held in Germany, France, and Austria, and that in the former country a special grant had now been made by the State Education Authorities for the training of stokers in their duties. Some details of the increase of steam pressures in land and marine boiler installations were then given by the author, and the greater need for skill and intelligence on the part of the firemen was emphasised.

The following are the more important paragraphs from Commander Caborne's paper:—

> We have seen what should be the qualifications of a thoroughly competent stoker, and we are aware how far short he frequently falls of the ideal we have set before us; and although this paper is entirely devoted to the question of stoking in connection with factories on land, it may not be inopportune to glance at the manner in which different classes of stokers are manufactured. In the case of the Royal Navy, the young men enlisted in the stoker branch of the Service are sent to a harbour depôt ship, where they are instructed by engine-room petty officers in the handling of shovel, slice, and pricker, and in the duties and general routine of the stokehold, and they afterwards perform duty on board instructional torpedo boat destroyers and torpedo boats, being the whole time under the strict personal supervision of capable teachers. The course of instruction, the exigencies of the service permitting, usually occupies some nine months, and then the full-fledged neophyte is drafted to a sea-going ship. In the case of the mercantile marine, as a rule no real preliminary training takes place, the man originally engaged as a coal-trimmer, after some little experience in that capacity, gravitating in due course to the higher rating of fireman or stoker.
>
> In this country there does not seem to be any provision made for the instruction or training of men destined to become stokers for land service. In fact, a happy-go-lucky want of system appears to prevail.
>
> I am of opinion that, as regards the efficient training of stokers, we might well adopt some plan analogous to that inaugurated by the Prussian Government in 1902. However, I would substitute municipalities and county councils for the State, the more that those bodies have already many facilities in existence for the adequate instruction and subsequent examination of candidates desirous of obtaining certificates of proficiency. If instructional courses for stokers were instituted, and if employers would give a preference to those persons who had been properly trained and could produce documentary evidence of the fact, the result would go far towards mitigating the terrible smoke nuisance under which we all groan, and would, at the same time, effect an enormous saving of that money which is now constantly wasted in this country through the imperfect combustion of coal.

A report upon the returns furnished by manufacturers who have succeeded in securing "The Abatement of Smoke in Factories" was then presented by Dr. Rideal. In February of the present year a circular letter was addressed by the Coal Smoke Abatement Society to sixty-three firms in the case of whose factories no nuisance had been reported for over six months.

Replies to this letter were received from forty-two firms, and of these thirty-eight supplied the information desired as to the methods in use for securing smoke abatement in their works or factories. Six of this number refused to consent to the publication of the details of the methods used.

As regards the remaining thirty-two, the following information is provided by Dr. Rideal:—Three of the thirty-eight firms have substituted gas engines for steam plant, leaving for further analysis the information supplied by the remaining thirty-five firms. Thirteen firms mainly ascribe their success in preventing the emission of smoke to careful stoking. A list was also given of the various fuels used by the thirty-five firms. Eighteen firms employed mechanical devices for economising fuel, and a series of replies as to the nature and work of these was tabulated. The majority of cases showed a saving, but two firms which have tried various mechanical devices emphatically disclaimed any benefit derived from them, and support the evidence of other firms in favour of careful stoking. Two firms ascribe success to the height of the chimney shaft giving an excellent draught, and one of them, in addition, to the fact that their boilers have been "set" with large flues. One firm is abandoning mechanical devices in connection with its boilers and steam engines, and is replacing them by electrical machinery, in the hope of effecting an economy. The general effect of the replies was that though the efficacy of many mechanical devices was not denied, yet the general consensus of opinion favoured skilled and careful stoking as of the first importance.

The Hon. Rollo Russell then read an abstract of his paper on "The Artificial Production of Persistent Fog." The author first stated that a natural country fog generally dissipates under the increasing sunshine of the morning. A town fog, into the composition of which smoke and solid matter largely enters, is protected against this action of sunlight by particles of carbon which stop the oblique thermal rays, and at the same time cause loss of heat by radiating directly upwards. The maintenance of a black or smoky fog depends upon the existence of a shallow stratum of cold air, within which the smoke is confined, and from which it cannot escape.

Smoke alone, without any natural fog, is able to produce a choking mist, when it cannot escape into the upper air, but the stratum, several degrees colder than the air immediately above it, is nearly always foggy, owing to the high humidity of our winter climate.

The creation and maintenance of a London fog follow from the retention of the smoke within a very shallow cold layer near the ground.

The extension of suburbs, with warmer surfaces than the green fields, tends to the diminution of local fogs but the area of smoke production is greater, and severe and widespread smoky fogs must still be expected. The maxima of cold fogs with danger to health and life will coincide with the maxima of smoke retention, so that the worst and most life-enslaving fogs are certain to recur soon. They belong to that type of weather which is most brilliant in the hills and on the South Coast, with a dry upper air and very low ground temperature at night. The darkest fogs have occurred on Sunday and Christmas Day, when the largest number of domestic fires were in use. Dark fogs are preventable simply by the reduction of the visible solid impurities cast into the air by the incomplete combustion of coal. If only anthracite or gas were used there would be less fog in London than in the surrounding country, for dripping, misty days are scarce in the City. The extended use of gas for heating and cooking purposes would go far to solve the smoke problem. In the meantime, the use of improved grates for domestic houses, and especially the use of greater intelligence and skill in the management of house fires, would greatly add to the clearness of the air in the metropolis. At present the evils of smoky and black fog, and the dirt of the London air, are largely owing to the neglect of the amenity of daily life. Regard for the interest of the whole community, as well as for the family, would, in the author's opinion, counteract the present waste of our resources, of which smoke and fog are a certain sign.

The next paper was upon "The Aims and Work of the Hamburg Smoke Abatement Society," and was contributed by Mr. John B. C. Kershaw, a foreign corresponding member of the Hamburg society. Mr. Kershaw opened his paper by stating that four-fifths of the factory and trade smoke was due to the unscientific conditions under which coal was used in the furnaces of boilers and other heating appliances. Figures were then quoted from the report of the recent Royal Commission on our coal supplies to prove that an economy of 33 per cent. of the fuel used annually for manufacturing purposes in this country was possible. It had been proved conclusively by the previous authors and speakers that smoke emission was allied with waste of fuel, and that the two essential conditions for burning coal without smoke production and with high thermal efficiency were: (1) Good stoking, and (2) scientific control.

In the case of the larger works and factories these conditions could be obtained when wanted, but in the case of factories having only one or two boilers, expert stoking and scientific control were not so easily obtained. The Hamburg society showed, however, how these conditions of good work could be obtained at low cost, in the case of small factories and small boiler installations. The following details of the Society were then given by Mr. Kershaw:—

> The work of the Society is controlled by a committee of six to nine members, elected annually from the rank and file of the Society at the general meeting. The technical and scientific work is undertaken by the staff of experts retained by the Society for this special work. At the date of the last report this staff consisted of a chief engineer, two assistant engineers, two instructors for fireman, and one clerk, while for special steam-raising and other trials three additional assistants had also been employed. The chief engineer attends the committee meetings and takes part in the discussions relating to the work of the Society. The funds of the Society are drawn from three sources:—(1) From the annual subscriptions of its members; (2) from payment for special work and reports for its members; (3) from payments for outside work.
>
> The Society is thus entirely self-supporting, and its success is dependent upon the value of the return it makes to its members for their contributions and fees.
>
> The objects of the Society, as set forth in the rules, are the attainment of the highest possible efficiency from the heating and boiler plants of its members, with the least possible emission of smoke. To this end, regular examination of these plants and of the methods of working them is undertaken by the expert staff of the Society, and suggestions are made for improvements when such are required. The education and control of the firemen in the proper performance of their duties are also undertaken by the firemen instructors on the staff of the Society. Comparative tests of fuel and tests of smoke prevention and other appliances of a similar character are also carried out by the expert staff, and the results are circulated amongst the members of the Society. Members of the Society can demand that their boiler or heating plant shall be regularly inspected, and that its working shall be tested and reported on at least three times a year. They have also the right to consult the chief engineer of the Society regarding improvements and alterations in the design and working of their plant.
>
> They, on their side, by their membership of the Society, are bound to allow the chief engineer and other members of his staff free access to their heating and boiler plant at all times, and are bound to make the necessary provisions for conducting the tests. They are also required to carry out the suggestions made for improving the efficiency of the plant, especially as regards the abatement of smoke, and to submit to the chief engineer all plans for the extension of the plant or for change in the methods of work.
>
> Each boiler or heating plant, when brought under the control of the expert staff of the Society, is tested at the earliest possible date, and a written report upon the results of the examination is submitted to the owner. Should the firing have proved inefficient, one of the firemen instructors is sent to the works to give practical instruction to the firemen employed there, and tests of the plant are made at intervals until this fault is remedied. Defects in design are similarly dealt with.

Mr. Kershaw closed his paper with figures showing that increased efficiencies—ranging from 10 per cent. to 17 per cent.—had been obtained in boiler plants placed under the control of the Hamburg Society, and urging the establishment of similar societies in the chief industrial centres of this country.

Mr. Joseph W. Lovibond next contributed a paper entitled "Precautions Necessary for Making Reliable Observations on Smoke Densities." The following extracts from the author's paper explain the principles and construction of the new smoke-recording instrument.

> In dealing with the nuisances arising from the consumption of fuel, the subject naturally falls into two divisions, the avoidable and the unavoidable; in reference to the former I was asked by the Coal Smoke Abatement Society to design an instrument capable of measuring and recording the density of smoke as it issued from chimneys. In designing such an instrument certain conditions must be complied with to make the readings reliable, namely:—All observations must be made under similar conditions. The light used for comparisons must be uniform in character. In the scale of standards used for matching the divisions must be equal, and the unit recoverable. It will be shown how these requirements are met whilst describing the instrument after considering the principles on which it is founded. The foundation rests on the Tintometer equivalent colour scales, which have the power of matching and recording in quantitative terms the colour sensation excited by any substance. Under this system the most complex colour can be qualitatively described by means of two colour terms and one light term, and when these are associated with their unit values of intensity, the description becomes quantitative.
>
> The equivalent colour scales are co-related to some chemical colour constants, and, therefore, have a physical basis by means of which their truth can be tested at any time. They have been

adopted by some international societies, and are used in many industries without question; a detailed description of their construction is given in the author's new work on "Colour Phenomena," and they were on the table for examination.

The instrument is a pocket edition of one used for measuring the colour of landscapes, gases, and incandescent bodies. It consists of a rectangular tube 1½in. by 1in., section 4in. long, one end is closed except a circular ¼in. opening used as an eyepiece. The purpose of the tube is to cut off disturbing side lights, which never equally affect two colours placed side by side, as when matched without this protection a change of position will certainly disturb it.

In the middle of the tube is a diaphragm having two ¼in. square apertures ½in. apart, one is intended to command the smoke to be measured, and the other half is filled with a beam of diffused daylight for comparison; the object of the ¼in. openings is to limit the field of view to the area of smoke under observation.

The two remaining papers presented at this session of the Conference dealt with the effects of coal smoke and black fog upon plant life, and were contributed by Mr. Arthur Rigg and Miss Agar. The former gave instances of the harm done to the trees and plants in the Royal Botanic Society's garden in Regent's Park by London smoke and fog, while the latter gave details of her own observation and experience as landscape gardener to the Metropolitan Public Gardens Association. Mr. Rigg stated that smooth-leaved plants and trees stood exposure to London's fog better than hairy-leaved plants and trees, and that after such a fog as that of Monday, December 11th, the leaves of all trees and plants required washing to free them from the horribly dirty deposit with which they were coated.

As a practical example of the dirtiness of London fog, leaves of an evergreen plant—the aucuba—had been gathered, and portions of these had been washed. The washed and unwashed leaves were exhibited to the Conference, and their marked difference in colour and appearance made a great impression. Miss Agar corroborated Mr. Riggs' remarks as to the harm done by smoke and fog, and invited members of the Conference to visit the garden of the Bank of England in the City, and to see for themselves the state of the plants and shrubs after the fog of Monday, December 11th.

This closed the list of papers presented at Thursday morning's session of the Conference, and the meeting was then thrown open for discussion of the address and papers.

Mr. Scott-Moncrieff opened the discussion by referring to previous conferences on this subject of Factory and Trade Smoke Abatement, and to a proposal made by himself in 1880, that all bituminous fuel should be partially deprived of its volatile matter at the gasworks, and that only the residual coke should be used for heating purposes. At that time the ideas of Sir William Siemens—namely, that gas and coke should take the place of coal for domestic and factory purposes respectively—met with more favour, but neither plan had been adopted. The revival of the idea twenty-five years later in two of the papers read before the conference at the previous day's meeting, however, proved that the solution of the smoke problem was still attracting attention, and was worthy of further consideration.

Mr. G. P. Gibson (Public Health Committee, Edinburgh) contributed some notes prepared by the City Engineer of Edinburgh relative to municipal control in Edinburgh as regards black smoke emission from factory chimneys. The nuisance arising from excessive smoke emission in that city had been largely reduced by inspectors, who visit the works complained of, and train the stokers in the proper performance of their duties.

Mr. W. H. Patchell, chief engineer of the Charing Cross and Strand, West End and City Electricity Supply Company, Limited, spoke as a representative of the Central Electricity Supply Station Engineers. He welcomed the conference to London on behalf of the Central Station Managers, and regarded it as a sign that some sweet reasonableness had at last come over the Smoke Abatement Society, and that education was now to take the place of persecution in the activities of this Society. Some of the authors of papers had referred to the value of induced draught and hot air for overcoming the smoke difficulty. His own experience with this arrangement had been a dead failure. Mechanical stokers, again, were of doubtful value. Under certain conditions they produced more smoke than steam, and they had not that elasticity required to meet sudden demands for current, which was a *sine qud non* in electric lighting stations.

Mr. S. D. Till inquired what was the cost of an instrument or apparatus for determining smoke density, and was informed by Mr. Lovibond that the price of the instrument described in his paper was two guineas.

Mr. J. Geldert, of Bradford, stated that some time ago he was appointed by the Bradford Dyers' Association to take charge of the steam-raising plants in all their works. The results had been a saving of 33 per cent. in the cost of fuel. He disagreed with Mr. Patchell regarding mechanical stokers, but these must be used with discretion and common sense in order to obtain the best results. If so used they could be adapted to burn all classes of fuel, and they would also burn bituminous fuel without smoke. He disagreed with Commander Caborne respecting the greater value and adaptability of hand stoking.

Mr. R. S. Richards referred to the excessive emission of black smoke in northern towns, and to the satisfactory position occupied by London in this respect as compared with towns. He agreed with all that had been said respecting the need for the education and training of stokers, and he would point out that mechanical stoking appliances were equally dependent upon the skill and ability of the men in charge of them.

Dr. Ormandy supported the proposals of Mr. Kershaw's paper as regards the reorganisation of the Smoke Abatement Society in this country. Referring to the comparative value of mechanical and hand stoking, he stated that they employed mechanical stokers in the works which he represented, and that they gave satisfaction. He disagreed with Commander Caborne's views on this subject. At the Warrington Works, however, the boiler plant had never worked satisfactorily until removed from the charge of engineers, and placed under the complete control of the chemical staff—and this was their solution for the smoke problem in all works where it still existed. In answer to Sir William Preece, Dr. Ormandy stated that the saving in fuel at Warrington since the boiler plant had been placed under the charge of chemists was equal to 1000 tons of slack per week—equivalent to £25,000 per annum—but that in making this estimate, allowance had been made for the extra boiler plant which would have been required to meet the demand for steam, if a very high efficiency had not been obtained from the existing plants.

Mr. W. Acton Berry, member of Council, Coal Smoke Abatement Society, spoke in the name of that Society, and defended its past action in promoting and aiding the prosecutions for black smoke emission within the metropolitan area. Nevertheless, he welcomed Mr. Kershaw's proposals for forming other societies on a more helpful basis, and would be pleased to see these carried into effect.

Mr. J. Macaulay, Chief Smoke Inspector, Liverpool, dwelt on the injurious constituents of smoke, and the losses due to the imperfect combustion of fuel. Manufacturers would never take any great interest in this question until they were convinced that smoke prevention was allied with fuel economy.

The speaker followed on with a plea for the use of automatic CO_2 recording apparatus, and with some remarks on mechanical *versus* hand stoking. In his opinion, the latter is best for meeting variable demands for steam.

Mr. E. P. Grove, chief engineer, Central London Railway, spoke as representative of one of the large London power stations which had been much persecuted in the past by the officers of the London Smoke Abatement Society. His company was doing all in its power to obtain smokeless and economical combustion of the fuel used under its boilers. Automatic CO_2 recorders are used in their works, and the stokers were paid a bonus on the results obtained. Large sums are now paid monthly to the stokers in this way over and above their regular wages. A fuel efficiency of 74 per cent. under the boilers is now obtained. His company had carried out a large number of experiments in stoking methods, and had tried many varieties of mechanical stoker, and it was still experimenting with a view to finding a satisfactory solution of the smoke problem as regards central power stations. But this work could not continue if the Coal Smoke Abatement Society adopted a persecuting spirit, and these experiments would have to cease if the officers of this Society decided to report and fine them for every slight emission of black smoke.

Bailie Anderson (Chairman Public Health Committee, Glasgow) stated that, in the city which he represented, a sub-committee of the Health Committee had taken over the work of the local smoke abatement society with most beneficial and striking results. This sub-committee maintained a staff of four engineers, and the efforts of this staff were directed towards educating both manufacturers and stokers in the methods of consuming fuel without smoke emission.

It must be recognised, however, that stoking was underpaid work, and that no great improvement was possible until this fact was recognised and remedied. Bailie Anderson closed by urging that all municipalities should take up this work, and that manufacturers should be interested in the question, and not persecuted by ill-advised prosecutions for smoke emission.

The final speaker at the morning's discussion was Dr. Butler (Medical Officer of Health for Willesden), who supported most of Bailie Anderson's remarks. At Willesden, however, the prosecutions for smoke emission which had recently been indulged in had led to abatement of the nuisance in the case of a large electric power station, and it was due to this action of the Health Committee of the Willesden Urban District Council that any improvement was to be recorded. Prosecution had therefore its use when wisely used and followed up.

This concluded the discussion.

INSTITUTION OF MECHANICAL ENGINEERS.

THE adjourned discussion on the Seventh Report of the Alloys Research Committee was re-opened on Friday evening last.

Professor J. O. Arnold, Sheffield University, remarked that he found himself in a somewhat difficult position, since the conventionalities of discussion demanded that he should criticise the authors in the plural, whereas, really, his criticism was very singular. He called attention to a paragraph on page 71 of the Report having reference to a criticism made by his colleague, Mr. McWilliam. It was quite evident the authors did not understand the important scientific points raised by Mr. McWilliam, nor the spirit in which that criticism was tendered; he must, therefore, speak a little more plainly. No question had ever been raised that forged and cast materials gave very different recalescence results. The point at issue was that the cast material referred to was in all probability highly oxidised and unfit for research, hence a forging test should have been made to prove that oxygen was not present in excessive quantities. The reason this criticism had been made was because the recalescence curves at the National Physical Laboratory did not agree with those obtained at Sheffield University. One of the latter and two of the National Physical Laboratory curves were thrown on the screen, and indicated that the Sheffield curve sharply differentiated the three critical points in low carbon steel, whilst the apparatus at the National Physical Laboratory confused them, and made it impossible to carry out experiments in the thermal ranges between the points. He considered that the recalescence installation at the National Physical Laboratory was faulty, because carried out in air with the couples packed in asbestos; the system was certain to involve "lag," whilst in Sheffield they worked in vacuo, with bright metallic contact between the couple and the steel. Turning to the micrographic section, Professor Arnold remarked that the authors asserted their results had entirely confirmed those obtained by M. Guillet, who had divided nickel steels into polyhedral, martensitic, and pearlitic groups. Specimens of polyhedral ferrite, polyhedral pearlite, and a polyhedral martensitic structure, as well as a polyhedral pearlite ferrite structure, were thrown upon the screen. He then remarked that the author's results failed in any way to confirm those of Guillet. He pointed out that in Plate I. three structures were labelled polyhedral, yet they were all different, only the top one presenting a structure resembling the polyhedra of ferrite. The middle or forged structure closely resembled one, three divisions to the left, which was labelled martensitic, and also one or two which were labelled pearlitic. Between all these structures, with three different labels, there was absolutely no generic difference, and they did not in any way confirm those of Guillet. Out of twenty-four photomicrographs labelled martensitic only one was distinctly entitled to that term. The President requested Professor Arnold to state what he considered the micrographs did show. Professor Arnold, in reply, remarked that they threw little or no light on the matter. Turning to the curves of pure nickel and of alloy K, on Fig. 19, page 69, Professor Arnold said the authors had asserted that the bulge in K was the thermal change point of nickel. He pointed out that it was well known that it was the presence of nickel which lowered the magnetic change point in iron, and if the nickel changed the iron must change too, and the material be magnetic. As a matter of fact, K was non-magnetic, but when dipped in liquid air at once became magnetic. Through the courtesy of his friend Mr. Hadfield he had obtained samples of K, which he handed with a magnet to the President, who demonstrated that K as forged was non-magnetic, on quenching in liquid air strongly magnetic. Professor Arnold then showed on the screen Osmond's magnetic curve for pure alloys of nickel and iron, and pointed out a second curve which he had deduced from the author's results, which showed the transformation point of K had been lowered from well above freezing point to about −80, owing to the presence of about ·4 per cent. carbon and 1 per cent. of manganese. He remarked that the allotropic theory not having been very successful in its application to iron and carbon alloys, an attempt was now being made to refer all the properties of iron and nickel alloys to allotrophy. He advised his hearers to regard these theories with very great caution, and exhibited a nickel iron alloy containing 13 per cent. of nickel which was nearly as magnetic as pure iron, and hence its iron must be admitted by the Allotropic School to be Alpha; therefore its remarkable stress of 91 tons per square inch could not be due to the alleged Beta iron, but rather to a definite alloy of iron and nickel.

Professor Gowland followed. He referred to the value of the work done and to the fact that some of the alloys investigated filled gaps in Guillet's series, and he directed attention to the necessity of avoiding any large intervals in the members of a series in investigating the properties of alloys. Had they not been close in this case the brittle zone might easily have been missed. The present alloys were not strictly comparable with Rudiloff's, since manganese is present, and, as the Report shows, has a very pronounced effect upon the results, quite small quantities changing the characteristics of the alloys. Speaking of the brittle zone, which is so marked a characteristic of some of the alloys considered, Professor Gowland asked if commercial nickel steel showed any such defect; if the nickel was well distributed through the ingots, or if segregation occurred? He regretted that the mechanical tests had not been duplicated, and was sorry that such small sections had been used, since they are not immediately comparable with ordinary commercial tests. Referring the audience to Table XV., he invited them to note the extreme irregularity of the alternating stress test, and asked how the results given in the table were to be interpreted. He was not satisfied with the corrosion tests, they should, he thought, for one thing, have been carried on for a much longer time. It has been shown that in certain alloys corrosion takes place much faster at first in one than another, but if the process is continued the conditions are reversed. He had no sympathy with the sulphuric-acid test, and since nickel steel was not likely to be used to contain acid, he failed to see the value of it.

Professor Barrett observed that he had crossed over from Ireland at the President's request to take part in the discussion, and regretted that he had not heard the first part of it. He expressed disappointment that England did not show a little more consideration for the work that was being carried on in Ireland. That country had been doing some excellent work in matters relating to the subject of the present Report, and yet he had not noticed any reference at all to it. Although the Report contained data that had been collected by Mr. Hadfield and himself some years ago, yet he failed to find any acknowledgment of their source. These results were published in the "Transactions" of the Royal Dublin Society from 1900 onwards. Mr. Hadfield had undertaken the testing of the physical properties of the alloys, and had done so with extreme thoroughness. He—Professor Barrett—had dealt with the electric and magnetic tests. He was gratified to find that the results obtained by the authors confirmed his. He dealt with only two points in the Report—electric resistivity and magnetic permeability. With regard to the former, he was pleased to see that the authors had examined the resistivity of the alloy containing between 3·82 and 11·39 per cent. of nickel. This he had not done in his research. The results obtained showed that the irregularities in the authors' series occurred between these two points. These irregularities were shown on the resistivity curve, which otherwise would have been perfectly smooth. Referring to the resistivity of the alloy containing from 19 to 20 per cent. of nickel, he stated that he had found the difference to be 40 microhms, whereas

the authors obtained 75 microhms difference. In one particular alloy mentioned, containing 14 per cent. of nickel, and 5 per cent. of manganese, a difference of 87 per cent. was produced by annealing. The difference between the authors' and Professor Barrett's results was attributed either to the heat treatment or to the shape of the rods, he having used large massive rods. Regret was expressed that complete hysteresis curves had not been given. He noticed that the authors had drawn attention to the change of properties of the alloys containing between 4 and 16 per cent. of nickel. Mr. Hadfield, it was stated, in research undertaken many years ago, had found that the mechanical properties of the metal change at 8 per cent. of nickel. In conjunction with Mr. Hadfield, in these same experiments, he had noticed that the magnetic change took place with 4 per cent. of nickel present. This, he was pleased to see, had been confirmed in the Report. Attention was also directed to the remarkable difference between the permeability of the very high and very low nickel steel. In conclusion, he expressed obligations to Mr. Hadfield for the excellent example he had set scientific people in the manner of carrying on this research work.

Mr. Wingfield confined his remarks more especially to impact testing. It is suggested in the Report that if the tup is insufficient to break all the specimens, the results are of greater value than if they are all broken, for by selective action the dangerously brittle steels are picked out. With this the speaker did not agree, explaining that although it was true that it showed some metals were more brittle than others, it nevertheless did not give any values as to how much more brittle they were. He strongly advocated tups of sufficient weight to break all the specimens. He exhibited a diagram to enforce his argument. Several of the test pieces that had been tested had been bent to a considerable angle before they were broken, and thus vitiated the result. Continuing, he dealt with the corrosibility of the metals, and suggested that the galvanic method should have been used. In this process the sample is made to form part of galvanic couple with a standard piece of platinum. By this method the relative rate of dissolving the material is obtained, and this occupies only a few minutes, as compared with months in the method used by the authors.

Dr. Carpenter then replied. He expressed gratitude for the courteous manner in which the discussion had been carried on. He particularly thanked Mr. Hadfield for the results of the heat treatment which he had carried out, and was in thorough agreement with his remarks concerning the tests that had been made at the temperature of liquid air. In answering Sir William White's criticism regarding the prohibitive cost of this class of steel, Dr. Carpenter cited the motor industry as a case in which nickel steel is being used with good results on a large scale. Answering the question on corrosion he gave the loss of weight in pounds per square foot. He had estimated that the metal B lost at the rate of 0·005 lb. per square foot in one month when immersed in ordinary water. When tested in salt water the same material lost exactly double that quantity. The values given for the metal K, treated in precisely the same manner, showed that the losses were 0·004 lb. and 0·006 lb. respectively. The calculations had been made on the assumption that corrosion had taken place uniformly. He quite agreed with Captain Sankey that the time had now come for the standardisation of impact testing. He referred to four different methods of performing shock tests, all of which were in every-day use, yet not any two of the four were comparable. The ratio of the elastic limit to the maximum stress, asked for by Mr. Harbord, would be included in the future Report. Having dealt with the questions asked at the previous meeting, Dr. Carpenter answered a few questions put to him last Friday. He remarked that it was impossible for him to answer all the questions then, as several of them required careful consideration. He then dealt with the attack made by Professor Arnold on the methods employed at the National Physical Laboratory. Professor Arnold had objected to the recalescence installation at the National Physical Laboratory, because the experiments were carried out in air with couples packed in asbestos, and he had said that this was sure to involve "lag." Dr. Carpenter, replying to this, drew attention to the statement in the Report, which reads as follows:—"In these doubtful cases the methods mentioned by Sir W. Roberts-Austen could be applied with great advantage." He stated that this method had been used in the Fifth Alloys Research, and he believed that in the discussion on that Report Professor Arnold had agreed to the method. It was certainly sensitive. One degree on their scale was represented by 8 mm., which was much more accurate than the method employed by Professor Arnold. It had further been stated by Professor Arnold that the steel was ruined by the presence of oxygen. If this was the case, he was asked to explain the fact that a curve was obtained as nearly as possible identical with that obtained by Sir William Roberts-Austen when he used a vacuum. The furnace was a reducing, and not an oxidising one. Answering Professor Gowland's question relative to the size of the test pieces, Dr. Carpenter explained that they had only a 10-ton testing machine at their disposal at the National Physical Laboratory, and considering the high tensile strength of a number of specimens tested, it would be apparent that it was quite impracticable to use larger test-pieces. In reply to Professor Gowland's questions concerning corrosion, Dr. Carpenter said that the future research work in this direction would be carried out on the galvanic principle. It was explained that the sulphuric acid tests had been made in order to compare the results with those previously obtained by Mr. Hadfield. This concluded Dr. Carpenter's observations.

Mr. Hadfield, in a few brief sentences, expressed the opinion that it would be a mistake to arrive at conclusions regarding the properties of an alloy simply by knowing its composition. He did not think that the manganese present did help to keep the quality uniform. He then referred in a few complimentary phrases to the work of Professor Barrett in this connection. He stated that due acknowledgment of his research work had now been included in this Report, and would be found in the final issue.

The President, in closing the discussion on the Report, added a few observations on the wonderful advance that had been made recently in the quality of steel. He once again, on behalf of the Institution, thanked the authors for their valuable Report, and also the various speakers for the interest they had taken in the debate.

Mr. Percy Longmuir was not present, and his remarks on the paper which had been sent up were not read at the meeting. It is an open secret that Mr. Longmuir is not in thorough agreement with Dr. Carpenter, and the following epitome of his views, which has been sent to us by the Secretary of the Institution, is remarkable for its reserve:—

"Mr. Longmuir, who had not been able to attend the discussion on the Report, but had been furnished with a proof of the first day's discussion, sent a written contribution for publication with the "Proceedings" in which he specially emphasised the following points:—Tensile tests of the cast material showed—

In the case of F an elongation of	6·3	per cent. on	1·7in.		
" " G "	4·5	"	"		
" " H "	6·3	"			

These results materially differed from those obtained from the corresponding forged alloys, and he had never previously met with steels which gave better elongations in the cast than in the forged state. He could not explain this divergence; however, the results were there, and the matter required further investigation. Turning to the solidification ranges, the fact that these determinations were made in the air should be emphasised. Whilst the influence of oxygen, or rather oxides, was not known so far as the solidification ranges of nickel steels were concerned, the probability was that these ranges were lowered. A similar lowering occurred in the case of copper, where the freezing point may be anything between 1084 deg. Cent. and 1063 deg. Cent., according to the extent of oxidation. Another analogy is found in the case of silver, and, as Le Chatelier and Boudouard have shown, a true point could only be obtained in an atmosphere of nitrogen. It was a matter of some regret that the area shown in the micrographs on Plates 1 and 2 was so small, and that the original scale of those on Plate 2 had been reduced."

Mr. Izod's paper on "Behaviour of Materials of Construction under Pure Shear," was then read in abstract, and discussed by Professor Lilly and Dr. Carus Wilson. At a little past ten o'clock the meeting was adjourned to January 19th, when the discussion will be resumed.

MOTOR CAR PROGRESS IN FRANCE.

(By our Special Correspondent.)

No. I.

IN making a comparison between the progress of motor car construction in England and France one is apt to overlook the points that constitute such progress. So far as England is concerned, the progress is enormous in the sense that, while the industry has developed at a very rapid rate during the past year, the construction of the cars themselves has been greatly improved until it was generally admitted at the Olympia Show that the British vehicles were of fully as good a quality as those turned out in France. It is true that the French engineer will not acknowledge this equality of excellence—it was not to be expected that he would; but he is still aware that the British industry is a factor that will have to be taken seriously into account in the early future, and makers are redoubling their energies to keep their hold upon the international market. In a general way it is easier to make progress by increasing manufacturing facilities and copying productions of standard design as perfectly as possible than still further to improve when this standard of perfection has been reached. Being only comparatively new comers in the industry, the British makers have been following up the beaten track, and are now close upon the heels of those who have hitherto been taking a long lead. Their progress has necessarily been more rapid than that of the French, who can now only refine their cars in small points of detail, which have to be worked out with great patience and long experiment. In carrying out this process of refinement, the French have the advantage of an exceptional experience which has taught them to be very careful in adopting new ideas until they have successfully withstood the severest test. They must know the conditions under which these tests should be applied, or, in other words, they should know every possible variety of treatment that any particular part or detail would be subjected to under the hardest service. A new apparatus is tried for months before the maker thinks that he is safe in fitting it to a certain number of vehicles, and it is only when these cars have been running a whole season satisfactorily that the new apparatus is finally adopted. Even after all this careful experiment, it often happens that a particular device fails to take the public taste. It is obvious, therefore, that the rate of progress must continue to be very slow, so long as the motor car is developed on its present lines, and it is in discovering all these little points that so much interest is centred in the Paris Salon.

It is because the points of interest must be dug out from the mass of mechanism, and can, therefore, only be discovered with difficulty by the general public, that the organisers of the Paris Exhibition have to rely entirely for an attraction upon an artistic display. It was supposed that by advancing the date of the Olympia Show a serious blow would be struck at the Paris Salon. This, at least, was the general impression conveyed by what was said and written during the show in London. It is certain that Olympia has profited considerably from the change, and has diverted an increasing amount of home business into British workshops; but those who thought that they would displace the pivot of international trade by simply advancing the date of the show in London failed to see the superiority of Paris as a centre of attraction. There is no doubt that the time will come, in the not very distant future, when England will monopolise the whole of her home trade; but until English organisers are able to surpass the French in their genius for display, it is difficult to see how London can rival Paris as the centre of international trade. The French see that when so much uniformity has been reached in motor car construction, everything depends upon the power to attract. In this respect the Paris Salon stands apart. Nothing like it in the way of decoration and attraction has ever been done before, and it really seems as if high-water mark has been reached in the organisation of automobile exhibitions. There is no building in the world more conveniently situated for an exhibition or more suitable for effective decoration than the Grand Palais. The organisers have done their best, regardless of expense, to utilise these advantages in the fullest possible measure, with the result that the marvellous combination of colour and light gives a vogue to the Salon which makes it one of the greatest social functions of the year.

The strong effort now being made to attract an international trade is also due to another cause, which throws an interesting light upon the present state of the automobile industry. While the French are carrying on a keen competition with foreign makers, and such vehicles as the Mercédès, Fiat, and others have successfully invaded France, the French makers are fighting amongst themselves for this trade. So long as the supply of cars was below the demand, it mattered little to one firm whether another was copying designs which they considered to be their own. They had enough to do without troubling themselves about what was being done by their neighbours. So little was thought of patents that they were considered to have little, if any, value at all, and everyone copied the best features of rival cars with the certainty that the inventor would do nothing to protect his rights. At a time when he was doing plenty of business, the owner of patented features in a car was not disposed to throw away a lot of money in fighting his competitors. The situation is now undergoing a change. There is an increasing difficulty in finding an outlet for the huge production of cars, and each maker is now looking jealously to his own interests. Those who have incorporated patented features in their cars are now bringing lawsuits against others who have pirated these inventions, wherefor the French industry is being threatened with all sorts of disagreeable complications. It is understood that the manufacturers of the Mercédès cars are bringing an action against one of the leading French firms for infringing the Maybach carburetter, and it is certain that if they succeed in this test case law suits will be brought against scores of other makers, who will be obliged to look out for something wholly different in the way of carburretting devices. Some years ago a member of one of the big French firms patented the "direct drive," in which the power, on the top speed, is transmitted direct from the engine to the driving axle without the intervention of intermediate gear. The principle has been applied so generally that no one suspected there could have been a valid patent until a test case was recently brought against a maker, when the claims of the inventor were upheld. It is understood that he now intends pursuing all the other infringers, representing probably about nine-tenths of the trade. The Maybach carburetter and the direct drive are such important features in cars that if the French trade is prohibited from adopting them the situation will become somewhat serious.

Another sign of the perturbed condition of the French industry is to be seen in the revolt of the trade against the leading French pneumatic tire manufacturer. In the hope of resisting the invasion of foreign tires M. Michelin sought to impose restrictions on the French makers, whereby they would be debarred from fitting their cars with tires of any other make. This attempt to interfere with the liberty of manufacturers was bad enough, but the tire firm made matters worse by their arbitrary attitude, whereby they alienated the sympathy of the whole trade. The trouble began with the French eliminating race this year, when the competitors were irritated at the way in which they were kept under the tutelage of the tire firm. Matters have since been going from bad to worse, until the representative of the tire manufacturer was forcibly expelled from one of the leading motor car works, and at the Salon there is only to be seen a small proportion of these tires on the vehicles exhibited, whereas in previous years they practically had the show all to themselves. We allude to these incidents as showing to what extent a perturbation of the French trade has accompanied the increasing competition for business both at home and abroad.

As we have explained above, the development of the French car continues to be in the direction of refinement in detail. A superficial inspection would convey the idea that the cars exhibited are practically the same as those shown last year, and it is only when going closely into details that we see that any appreciable progress has been made in construction. As little more can be done with the general design of the car, attention is being entirely concentrated in an effort to simplify the vehicle, and give it more elasticity and greater ease of control. How far this has been done will be seen when we come to describe the many interesting features that make up the sum of progress during the past year. In a general way it may be said that there is a tendency to run the engines at a higher angular speed—at all events, for the higher powers—and everything is done to avoid any appearance of complication by suppressing unnecessary parts or placing them where they will not interfere with the accessibility of the valves. Clutches have undergone a considerable improvement, and, in fact, nearly everywhere we see little advances which, taken altogether, are conducive to more satisfactory running, and, in a word, tend to make the car perfectly homogeneous. It

is true that there is still a great deal to be done to secure absolute homogeneity, but manufacturers are certainly working along the right lines to secure the best results with the standard pattern of vehicle. As showing how much importance makers are attaching to what may be called the automatic character of the vehicle, we need only refer at the moment to the various devices being introduced for starting the engine from the seat. A full description of these various devices will be given in a future article. If the petrol car is undergoing steady improvement in the way of refinement, the same thing can be said of the steam vehicle, which seems yet awhile to be in no danger of undergoing the utter extinction that was prophesied for it some time ago. In petrol-electric vehicles there are also novelties that we shall deal with in future letters, and motors, carburetters, &c., offer a mass of novel ideas and applications which make the Paris Salon unusually interesting.

THE TRAINING OF CIVIL ENGINEERS.

THE present session of the Glasgow Association of Students of the Institution of Civil Engineers was begun on Monday, 20th inst., when the president, Mr. Donald A. Matheson, M. Inst. C.E., engineer-in-chief of the Caledonian Railway, delivered his presidential address, being introduced to the students by the past president of the association, Mr. J. E. Harrison, M. Inst. C.E. Mr. Matheson devoted his address to the subject of the developments taking place in the several branches of the profession of civil engineering, and of the most fitting education to meet the conditions.

At the outset Mr. Matheson pointed out how essentially modern civil engineering was as compared with architecture and law, describing the process of evolution in all the branches of the profession, noting, for example—as in the case of masonry *versus* steel in construction, and gas *versus* electricity in lighting—how what might be considered as retrograde movements were really instances of the survival of the fittest. Reference was also made to the marvellous advance in electric science, which might be said to be changing the conditions, if not the customs, of life. Dealing more particularly with the work of railway engineers in the future, Mr. Matheson indicated that the tendency was—rather than in the construction of new railways—in the direction of betterment by the widening of existing lines; the providing of additional accommodation; and the extension and improvement of the great terminal stations for goods and mineral traffic as well as for passenger traffic in the principal cities of Europe and the United States. In New York City alone, at the present time, money to the amount of something like 20 million pounds sterling was being expended in providing augmented terminal station accommodation. Improvement in permanent way had also in recent years been most marked, and there had been continued evolution of the steam locomotive engine which, however, was now shadowed, if not absolutely threatened, by the electric motor. Many of the pessimists of ten years ago had lived to see the single line mileage of railways in the United Kingdom increased by 3000 miles in the past decade, Scotland's share being 550 miles, and there were signs that much railway work still remained for civil engineers to execute. In Canada and the United States especially the new railway field could be described as practically illimitable. It was the same in other branches of the profession, there being no indication of finality in the construction of waterworks, drainage works, dock works, &c., so that it was encouraging to the young civil engineer to know that in respect of commercial enterprise and relative civil engineering work the immediate future promised to be quite as prolific as the past. There was also the pressing question of rapid transit in large cities and suburban districts to be dealt with, involving immense interests, and presenting engineering and economic problems, the solution of which had been the special study of some of the most eminent civil engineers of the day. In this connection it was pointed out that the Royal Commission on London Traffic had put forward a scheme, the carrying out of which would involve an expenditure of over 30 millions sterling.

Proceeding to deal with the education of young civil engineers, Mr. Matheson emphasised the importance of their so preparing themselves for their duties as to ensure their being able not only to design engineering works, but to carry them to successful completion, both from the economic and from the engineering point of view. They must make the cost proportionate to the efficiency, and never forget that economy was a great revenue. The prospective civil engineer during the last two years at school should specially study mathematics, modern languages, and freehand and geometrical drawing. He emphasised the relative value of draughtsmanship in the training of the civil engineer, it being the "language of construction" and the expression of civil engineering. It was imperative that, as well as being proficient in mechanical draughtsmanship, the young civil engineer should be properly taught freehand drawing and sketching from the model, in order that the eye as well as the hand might be properly trained. Immediately after leaving school he should take the engineering course at a university, extending over three years, devoting the summer vacations to work in a bridge-building yard. This should be followed by one year's training in mechanical engineering workshops, and a three years' apprenticeship with a civil engineer. At this stage some experience in the office of a busy architect would be advantageous. His subsequent experience should be gained while acting as an assistant in a civil engineer's office, as an engineer on the engineering staff of a public works contractor, and as a resident engineer, the object of the latter part of his training being to enable him to "do things," and to make him a man of affairs and an engineer of men. After this his professional career would be governed by circumstances and propinquity; but as this was the age of the specialist, the young civil engineer must of necessity specialise and devote himself to a particular branch of the profession.

The critical period of a young civil engineer's life was that between the ages of twenty-five and thirty. He should then be acquiring—preferably on the engineering staff of a public works contractor—practical knowledge of the quality of materials and workmanship, of the methods of construction, of the costs and prices of work, and of organisation and administration. Such experience was invaluable, and should be made essential for admission to associate membership of the Institution of Civil Engineers. In addressing them thus, Mr. Matheson said that he was conferring upon himself the honour of holding a brief for the contractor's engineer, whose responsible duties and practical knowledge fitted him for becoming a true civil engineer—the man with initiative, capable of setting his wits to work and "doing things." Such a man was George Stephenson, who exhibited the quality of thoroughness in practical knowledge, and the capacity for managing men and organising and directing to such a degree as to entitle him to be ranked amongst the greatest of the "old masters" of civil engineering. The engineering staff of a contractor Mr. Matheson described as one of the best of engineering colleges; and, while advocating the equal importance of thoroughness in practical experience and theoretical knowledge, he stated that he would leave something unsaid if he did not commend the commercial aspect of civil engineering, for there was much truth in the statement that the substance of the art and craft of civil engineering was the capability of making a sovereign earn the most interest.

THE ROLLING-STOCK OF RUSSIA'S RAILWAYS.

AFTER taking close upon three years to digest the mass of material laid before it, the Russian Ministry of Ways of Communication has issued some very interesting statistics with regard to the rolling-stock in use on the Russian railway system at the end of 1902. The following figures are exclusive of those relating either to the Finnish railways or to the Eastern China Railway, which is known commonly as the Manchurian Railway. Without the Finnish railways and the Manchurian Railway, the total length of Russia's railway system at the end of 1902 was 36,284½ miles, and the rolling-stock thereon used consisted of 14,326 locomotives, 16,239 passenger coaches, with 51,931 axles, 1656 luggage vans, 331,961 goods wagons, with 675,485 axles, and 558 mail vans. Thus for every kilometre, or five-eighths of a mile, of the railway system there were 0·246 locomotives, 0·894 passenger coach axles, and 11·636 goods wagon axles. How inadequately the Russian railways are provided with rolling-stock may be seen in a comparison with the returns for the German railways in 1902. The total length of the railway system in Germany in 1902 was 33,563 miles, and to every five-eighths of a mile there were 0·378 locomotives, 1·864 passenger coach axles, and 16·08 goods wagon axles. Now, if there was any part of the railway system which Russia ought to have provided with sufficient rolling-stock it certainly was the railways beyond the Urals—that is, across Siberia and down to the Pacific coast line. However, the authorities do not seem to have realised the extent of the duty that lay before them, and the war with Japan brought out the many shortcomings of Russia's railway methods in Asia. Thus, at the end of 1902 the Siberian, Trans-Baikalian, Ussuri, and Central-Asian Railways had a total length of 5187 miles; yet the rolling-stock of the four railways consisted only of 1431 locomotives, of 5107 passenger coach axles, and of 51,600 goods wagon axles.

The great fault of the authorities in charge of Russian railway construction has been that the rolling-stock, and especially the locomotives, have not been augmented to keep pace with the new lines of railway laid down. The authorities cannot complain that they "did not know anything about it," for after every Russian harvest, and whenever any extra claim has been made upon the carrying capacities of the various lines, the failure of the lines to cope with the least increase of freight has always come to light at once. One easy way out of any trouble with regard to such freight has been that of "borrowing" a few trucks from other lines just to tide over the extra pressure; the evil itself was not remedied. For some months the Russian Press has made a point of recording every few days either the number of trucks that are being held up at various stations owing to lack of locomotives, or the quantity of grain and other products that is lying carelessly warehoused or exposed to the weather at many a roadside station, just because no trucks are available for carrying the corn to the places where it is needed. Last February as many as 160,000 truck-loads of corn were lying at the railway stations for lack of transport, and hundreds of thousands of tons of coal could not be carried from the Donetz coal region for exactly the same reason. For many months the goods traffic both on the Samara and Zlatoust line and on the Siberian main line came to an end because the military authorities had taken all the available goods wagons for conveying the troops to the Far East. Again, the authorities keep too many worn-out locomotives running; thus, in 1903 there were running 115 locomotives aged from forty-three to forty-five years, 292 aged from thirty-eight to forty-two years, 1002 aged thirty-three to thirty-seven years, and so on. Most of the locomotives and passenger-coaches have not yet been fitted with continuous brakes. In 1902 only 4168 locomotives out of 14,325 were fitted with continuous brakes.

In 1902 47 per cent. of the Russian railway locomotives used anthracite and coal, 39 per cent. used petroleum and oil refuse, and about 14 per cent. used wood, turf, and briquettes as fuel. Coal is used almost exclusively for feeding the locomotives running on the Siberian railways, and coal and oil on the Central-Asian Railway. Of recent years oil fuel has taken more and more the place of coal; thus, in 1894 29·4 per cent. of the locomotives on Russian railways could be fed with liquid fuel, in 1895 the percentage was thirty-two, in 1900 it was 35·1, in 1901 it was 37·2, and in 1902 it was 39. During 1901 the Riasan-Ural Railway used 253,726 tons of liquid fuel to drive its engines, the Vladikavkas Railway in Caucasia used 232,596 tons, and the Trans-Caucasus Railway used 177,084 tons. Just as oil fuel had become so popular on Russia's railways, misfortune overtook the Empire, for most of the oil wells at Baku were destroyed by the Armenians and Tartars, and the Russian oil industry has received a terrible blow; already those locomotives adapted solely to burn oil fuel are feeling the absence of oil fuel, and on some lines these oil-fed locomotives are being reconstructed so that they can burn coal. Here again disaster follows close upon Russia's heels, for, owing to railway strikes, the absence of an adequate number of trucks, and to the generally unsettled state of the country, the Russian coal industry is quite unable to supply the coal now needed for the railway locomotives, and coal will have to be imported from abroad.

The whole network of Russian railways consists of twenty-eight lines connected with each other, and of eleven isolated lines. The State works about 60 per cent. of the whole system, and the remainder is in the hands of public companies. Mismanagement is not to be blamed entirely for the shortcomings of to-day. It must be borne in mind that the Russian railways suffer from unsatisfactory gradients and curves, from being laid down in single track, from lack of sidings, from consisting often of only one main line very badly built, from the great distances that separate stations, and, chief of all, from the fact that the builders of lines in the past seem to have exercised infinite care in the direction of laying down a line in such a way as to pass by towns, large or small, at some distance. A railway that runs past a town at a distance of two or more miles cannot benefit such a town as railway communication ought to and nearly always does. The straight line of railway, 404 miles long, connecting St. Petersburg with Moscow, and called the Nicholas Railway, is the best specimen of this great fault of Russian railroads.

WASTE PRODUCTS FOR MOTIVE POWER.

SOME interesting experiments have recently been carried out in connection with the use of waste products for motive power at Noisel in France. In general the portable or fixed engines which are used on the farms are obliged to use coal, which must be brought to the spot at considerable expense. The use of gasoline or oil motors is too expensive to be practicable at present on farms. To see whether the problem of cheap power could not be solved by the use of different kinds of vegetable waste products which are so abundant, the present experiments were undertaken, and the various products were burnt in a gas generator, which in turn ran a duplex motor. Wheat straw, oats, waste hay, leaves, reeds, &c., were used. The idea in the present case is to form groups among the neighbouring farmers, who would possess the apparatus in common, in which case the first cost would not be heavy, and they would then have a source of cheap power, using a 50 horse-power gas engine. In the present trials the products were collected, and, after drying, were formed into bales weighing 800 lb. per cubic yard. The straw was chopped before baling. The following are some of the results obtained on burning waste materials in the gas producer. The latter, which is of the Riché type, using an upright column, only requires a little coke to keep up the operation. In the case of waste hay it takes 2·25 lb. to produce a horse-power hour, and the cost is estimated at about 5d. The hay was charged in the gas producer without taking any special precautions, and was packed down with a rod. The alkaline slag which comes from the furnace may be used as a fertiliser. In the case of wheat or oat straw the ash and water are somewhat less than in the former case. The horse-power hour can be produced by burning 2·31 lb. of straw at a cost of about the same as with hay. Reeds or moss cannot be used to advantage in the producer unless they are well dried. In fine weather they can be spread in the sun. In the case of dead leaves—ash leaves which had fallen in the autumn before—allowing the cost of collecting, transporting, and compressing to be about 45s. per ton, we find that the horse-power hour works out at about 4d. Sawdust, shavings, and wood splinters were also tried. Poplar sawdust takes 3·1 lb. to give 1 horse-power hour, costing about 5d.

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETING.—A meeting of students of the Institution of Civil Engineers was held at the Institution on Friday evening, the 15th instant, Mr. E. W. Monkhouse, M. Inst. C.E., in the chair, when a paper on "Photometric Tests of Street Illumination in Westminster" was read by Mr. E. E. Mann, Stud. Inst. C.E. The reading of the paper was followed by a discussion, in which Messrs. L. F. de P. Peyrecave, A. E. Snape, B.Sc., R. J. Francis, H. S. Hoskings, W. T. Butler, D. E. Sparks, H. S. Coppock, B.Sc., and J. E. Montgomery, Studs. Inst. C.E., took part.

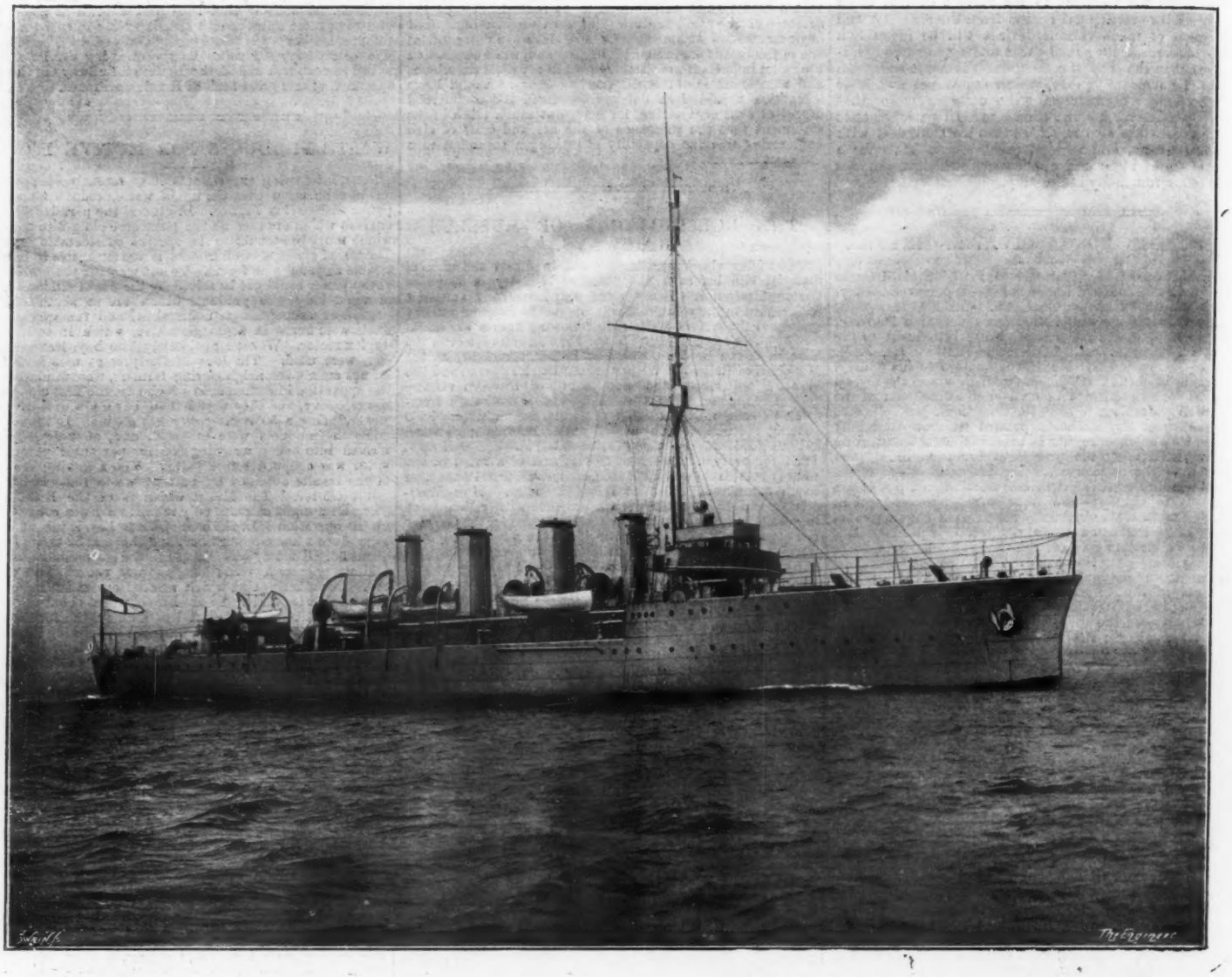
THE BIRMINGHAM ASSOCIATION OF MECHANICAL ENGINEERS.—The Birmingham Association of Mechanical Engineers held their usual bi-monthly meeting at the Grand Hotel on Thursday evening, at which a presentation of a diploma was made to Mr. E. A. Dowson for the best paper contributed during the session 1904-5. A paper was then read by Mr. J. D. Bailie, of Leeds, on "The Parsons Steam Turbine," in which, after describing the evolution of the steam turbine, he claimed the superiority of this type of engine over reciprocating engines, both for economy in working and space required, and pointed out its particular suitability for work in which very large power was required, such as electricity stations, collieries, marine work, &c. He proved his point by comparisons of the results of various tests. The paper produced a very animated discussion, and the meeting closed with a vote of thanks to the lecturer.

DREDGER FOR NEW SOUTH WALES.—On the 14th inst. William Simons and Co., Limited, Renfrew, launched a light draught twin-screw suction hopper dredger named the Tethys, constructed to the order of the New South Wales Government for the removal of the sand bars on the New South Wales seaboard. This vessel, which is the third suction dredger constructed by W. Simons and Co. for the New South Wales Government, has been specially designed by the builders for work in shallow rivers, her load draught being 6ft.; the fore-foot is well cut away to facilitate rapid turning. Two independent sets of triple-expansion engines are fitted for propelling the vessel at a speed of about 10 knots per hour, steam being supplied from two Babcock and Wilcox water-tube boilers constructed for a working pressure of 200 lb. per square inch. Two powerful sand dredging pumps are provided, each driven by an independent set of triple-expansion engines, and each connected to separate suction pipes, one on either side of dredger looking aft, and arranged to dredge when the vessel is steaming slowly ahead. The Tethys was launched complete with steam up, ready for work, and will shortly go down the Clyde for trials. She has been built under the direction of Mr. C. W. Darley, M. Inst. C.E., consulting engineer to the New South Wales Government.

THE INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' ASSOCIATION.—A paper was read on 11th December by Mr. A. W. Waddy, graduate, of London, entitled "Notes on Organisation in Small Engineering Works." The author opened his paper by insisting on the absolute necessity of avoiding verbal orders, pointing out the troubles arising from trusting too much to one's memory, and suggesting that all orders should be typed with a carbon copy. Books of account did not enter into the paper, as being in the secretary's department, and only indirectly under the manager. Such books as the goods book, order book, job book, symbol lists, and specification sheets were dealt with, and the various samples shown were criticised. The general lay out of the works was touched upon, and the advantages of studying the comfort of the men discussed. General rules were laid down for drawing-office practice, and the allocation of patterns and tools, such as milling cutters, taps, drills, &c., to the various jobs, was discussed at length, opinion being divided between considering those as running expenses, chargeable on all jobs at a rate fixed by previous experience, or charging them up to the job on which they were originally used. Mr. J. Rossiter Hoyle, member of Council, occupied the chair. The following graduates took part in the discussion:—M. G. Duncan, Edwin Barrs, S. S. Nevill, P. Petrie, A. B. Symons, T. Drayton, A. Marshall, F. A. Smith, and Mr. Waddy replied.

H.M. FLEET SCOUT ATTENTIVE

SIR W. G. ARMSTRONG, WHITWORTH AND CO., LIMITED, NEWCASTLE-ON-TYNE, BUILDERS



H.M.S. ATTENTIVE.

The trials of H.M.S. Attentive, carried out last week by Sir W. G. Armstrong, Whitworth and Co., Limited, mark the completion of the interesting experiment made by the Admiralty in having eight Fleet Scouts built by private contract. This experiment included not only the creation of a new type of war vessel, but the departure of giving the leading firms in the country a free hand in the attainment of certain ends laid down by the Admiralty, a procedure which differs radically from the custom hitherto obtaining of letting a contract for the construction of a vessel, the design and all the salient dimensions of which have been previously settled by the technical officers of the Admiralty. Under this latter system the capabilities of the private firms, as far as designs are concerned, are not called into play, and success or failure chiefly depends on their resources and experience in the mechanical processes of construction merely. While this procedure is desirable and, indeed, necessary for the production of a homogeneous fleet of battleships and cruisers, the Scout class admitted of a form of tender which should tax both the scientific and practical resources of the shipbuilder and engineer, and so give the Admiralty in each case the best each firm had to offer, instead of having a stereotyped class all of the same merit. In our issue of August 4th we gave very fully the particulars of the vesse s as designed by the four different firms—Messrs. Cammel Laird, the Fairfield Company, Armstrong, Whitworth and Co., and Vickers, Sons, and Maxim, so that it will be sufficient to recall here that the lengths vary between 374ft. and 360ft. The beams between 40ft. and 38ft. 3in., and the draughts between 18ft. 10½in and 12ft. 6in. The displacements range between 3060 tons and 2620 tons, and the horse-power developed on trial between 17,500 and 14,300. It will be seen, therefore, that there was considerable diversity of opinion amongst the four firms as to the necessary proportions to obtain the best results. Hardly less diversity has characterised the speeds obtained, the highest and lowest recorded on the six and a-half hours' full power trials being 25·88 and 25·07 knots respectively. The higher figure is that realised by H.M.S. Attentive on her trials last week, and it places her half a knot ahead of any of her seven sister scouts, the next best speed recorded on the six and a-half hours' trial being that of H.M.S. Adventure, also built by Sir W. G. Armstrong, Whitworth and Co., which did 25·4 knots. While the sustained speed of 25·88 knots during six and a-half hours probably places H.M.S. Attentive as the fastest vessel, other than destroyers, in the world, it will be seen from the detailed results given in the table, that throughout the last hour of the trial she maintained a speed of no less than 26¼ knots, and this splendid result coming at the very end of an onerous trial, speaks volumes for the efficiency of her boiler equipment. In previous issues we have fully described the machinery and boilers of the Adventure, with which those of the Attentive are identical, both sets being designed and built by Messrs. Hawthorn, Leslie and Co., St. Peter's Works, Newcastle-on-Tyne. The only difference in the two ships lies in the propellers, and the better speed in the Attentive is the result of a lengthy series of experiments conducted with a view to determining if better proportions were obtainable for the second vessel than had been secured in the Adventure. In explanation of the table it is necessary to point out that the specified duration of the trial at full power is eight hours, but the first hour and a-half are occupied in making six runs over the measured mile to determine the relationship between speed and revolutions; the subsequent six and a-half hours' steaming constitute the speed trial proper. The Admiralty is to be congratulated on this valuable addition to their Fleet Scouts, and the builders on the marked success that has attended their design. We give an illustration of the vessel as she appears under steam.

Details of Full Power Trial, 12th December, 1905.

	6½ hours.						
	½ hour.	3rd hour.	4th hour.	5th hour.	6th hour.	7th hour.	8th hour.
Steam in boilers, lb.	250	250	250	250	250	250	250
Steam at engines, lb.	242	240	240	240	242	245	245
Air pressure in stokeholds, in.	2·3	2·8	3	3	3·1	3·2	3·1
Vacuum, in.	25·25	25	25	24·75	24·75	24·75	24·5
Mean revolutions	251·4	256·9	257·25	257·65	257·55	256·85	260·6
Indicated horse-power	14,939	16,416	16,217	16,512	16,110	16,292	16,879
Speed	25·283	25·836	25·87	25·91	25·91	25·83	26·2

Liverpool Engineering Society.—The annual dinner will be held at the Adelphi Hotel Liverpool, on Thursday evening, January 18th, 1906, at seven o'clock.

Glasgow University Engineering Society.—On Friday evening last the James Watt Engineering Laboratories at Gilmorehill were the scene of a most successful function, held under the auspices of the Glasgow University Engineering Society. Mr. G. T. Beilby, the honorary president of the Society, received the guests in the main laboratory, aided by Mrs. Beilby, Professor and Mrs. Barr, and Professor and Mrs. Biles. The guests numbered upwards of 500, and included, in addition to the members of the Society and their friends, representatives from most of the engineering and shipbuilding firms in the district, and a large proportion of the Senate and the teaching staff of the University. During the early part of the evening various machines in the laboratory were running, test pieces of iron and steel were broken in the large 100-ton testing machine, and a number of electrical experiments and demonstrations were made. Amongst the latter those of Mr. F. Soddy, M.A., attracted particular attention and commendation. Shortly after the guests had assembled, Dr. J. Blacklock Henderson, the newly-appointed Professor of Applied Mechanics at the Royal Naval College, Greenwich, was presented by Mr. Beilby with a barograph, as a token of the esteem and friendship of his many friends in the Society. Dancing took place in the large drawing-office on the top floor, which was prettily decorated with garlands of Chinese lanterns, fitted with electric lamps. The undoubted success of the entertainment was unanimously attributed to the able management of Mr. Charles McNeil, jun., who, besides being one of the honorary secretaries of the Society, is one of the most prominent and popular students in the department.

LOCOMOTIVE TESTING PLANT AT SWINDON

(*For description see page 621*)

PULLEY SYSTEM

AIR COMPRESSOR

END VIEW OF TESTING PLANT

LOCOMOTIVE UNDER TEST

RAILWAY MATTERS.

WE understand that Lord Londonderry has been made a director of the North-Eastern Railway Company.

THE Virginia and Carolina Coast Railroad has begun the construction of 130 miles of the proposed road between Norfolk, Va., and Beaufort, N.C.

DETAILS of the cost of the Simplon Tunnel undertaking show that there has been an expenditure of nearly £3,500,000, or £160,000 per kilometre.

THE Western Maryland Railroad has acquired the Georges Creek and Cumberland Railroad for £500,000. The line runs from Cumberland to Lonaconing, a distance of about 47 miles.

THE London County Council propose to proceed as rapidly as possible with the electrification of the tramways between Aldwych and the Angel, and the reconstruction of the Islington tramways.

THE Board of Trade have published the amended and confirmed Order authorising the construction of a light railway from Hope Station, on the Dore and Chinley line, to Bradwell and Castleton.

THE Northwich Urban District Council have resolved to oppose the application of the promoters of the Warrington-Northwich Light Railway for an extension of time wherein to acquire lands for the construction of the railway.

THE Leigh Council have appointed a sub-committee to consider and report as to whether the tramways authorised by the Act, 1903, should be constructed with a view to their being worked by the Corporation or leased to a company.

ELECTRICITY is absolutely the only safe means of lighting a railway train. The *Electrical Review* looks forward to the time when the Government will make its adoption compulsory, and thereby improve the lighting, reduce the cost, and abolish danger.

THE projected new Canadian railways and extensions of existing lines amount to 7444 miles, and involve the expenditure of £36,400,000. The work is expected to occupy from three to five years, and for next year alone the Dominion will take 100,000 tons of material.

THE several railway companies having termini in the City have received communications from the Corporation of London suggesting that, in the public interests as well as in their own, they should obtain reports as to the stability and safety of their stations in the City.

THE Grand Trunk Pacific Railroad Company has secured extensive coalfields near the Pacific Coast, and has lately paid the first instalment for the Cassiar fields. These are 60 miles east of Laurier, the Pacific terminus of the road. It is said that the property includes 42 square miles of coal lands containing coal of high quality.

THE Colchester Tramways Committee have considered the manager's report as to the ticket system of collection of fares in lieu of boxes, and the introduction of intermediate stages, and resolved *nem. con.* to recommend that the ticket system be adopted, a sub-committee being appointed to fully consider the best means of working the system.

A THROUGH Pullman train to the city of Mexico is to begin running on January 16th from St. Louis *vid* the Iron Mountain line and the National Railroad of Mexico. The schedule time is to be 55 hours from St. Louis to Mexico City, and a through dining car will be run, which is said to be the first regular dining car service to be established in Mexico.

LAST week the French Chamber resumed the discussion on the question of the purchase of the Western railways. The Minister of Public Works stated that he had not sufficient financial or economic data to hand to come to a decision. He asked the Chamber, therefore, to postpone any vote on the subject, and a motion for adjournment was carried by 285 votes to 270.

AT the last Bournemouth Town Council meeting the borough surveyor reported that, in order to put the existing track on the Poole Light Railway in proper condition, it would be necessary to expend about £3000, which sum would include new points and crossings. It was decided to proceed with such works as are absolutely necessary to maintain the track in proper working order.

THE Darlington Tramways Committee reported to the Council at their last meeting that the net loss on the year's working had been £1400, or £27 per week, equal to a 2d. rate. This, however, did not include depreciation, which might be put down as something about 5 to 7½ per cent. This was under the ½d. fare system. Passengers had increased 20 per cent., but the receipts had only increased 1½ per cent.

THE London, Brighton, and South Coast Railway Company is about to substitute rail motor cars on its branch line between Brighton and Kemp Town for the existing trains of the ordinary first, second, and third-class type of carriage. The new service, which will begin on January 1st next, is a considerable improvement. It will be performed by petrol-driven cars, of one class only, capable of seating forty-eight passengers.

CONSIDERING the many disadvantages due to the practice of shifting the points of tramway lines by the conductor, the Prefect of Police has invited the Paris and Seine companies to devise means for stopping a car after passing the points, so as to allow the conductor to remount without danger. This is only a transitory measure, however, as it is desired that the driver shall work the points from the platform; and if suitable means cannot be found, special pointsmen are to be employed.

ONE of the American railroads is about to introduce an innovation in the collection of fares at Chicago, according to the *Railroad Gazette*. Hereafter a "train auditor" will follow the conductor on his rounds. When the conductor collects a fare the auditor will examine it, enter the amount in a journal, and if change passes he will also make a note of that fact, so that every transaction may be complete. It is thought that this is only the beginning of a revolution in the method of collecting train fares.

ANOTHER instance of the injury being done to London by the excessive rates is to be found in the fact that the Great Northern Railway Company proposes to move a number of clerks from King's Cross to Peterborough. It appears that a large amount of work, which was once done at Peterborough, is now carried on at Doncaster, and the company, in consequence, has on its hands at the former town a considerable area of unoccupied space, formerly used as sheds for coaches. These sheds have been altered and renovated, and the company proposes to use them in future as offices.

THE Pennsylvania Railroad Company's new cut-off from Ravenna eastward to Niles, Ohio, where connection is made with the Pittsburg, Youngstown, and Ashtabula division, has been opened for business. The Cleveland and Pittsburg, between Cleveland and Ravenna, has also been rebuilt. The company now has lines between Cleveland and Pittsburg over three routes—one *vid* Ravenna and Youngstown, 138 miles; one *vid* Alliance through Homewood, 140 miles; and the other *vid* Alliance and Wellsville, 150 miles.

NOTES AND MEMORANDA.

THE United States Navy Department has selected the names Octopus, Viper, Cuttlefish, and Tarantula for the new submarine boats being built at the yard of the Fore River Company at Quincy, Mass.

THE steel chimney of largest diameter in the United States is at a smelting works at Douglas, Ariz. This is 200ft. in height, 25ft. internal diameter, and 34ft. diameter at the base. A steel chimney at Mapimi, Mexico, is 300ft. in height, 14ft. internal diameter, and 24ft. in diameter at the base.

THE census which has recently been taken in Germany indicates that there are now thirty-four cities with over 100,000 inhabitants, eighteen of these having over 200,000, whereas thirty years ago there were only twelve cities with a population of over 100,000, and only four had over 200,000 inhabitants.

ONE of the first calculating machines was invented by the philosopher, Blaise Pascal, about the year 1642. It consisted of a series of wheels connected with one another and engraved with the figures 0 to 9. The carrying of tens was accomplished by hand, however, and the machine was found to be of little use in practice.

IN the Pennsylvania oilfields, where the separate strata have a remarkable persistency of identity, many that are oil-bearing at 1000ft. or more depth can be identified miles away, where they crop out on the surface; but no oil stains can be detected in such surface rocks except where erosion has actually cut into the oil horizon.

ALTHOUGH quartz itself, as found in Nature, is as brittle as glass, yet when melted and blown into vessels it withstands the sudden changes of temperature that metals will endure. A red-hot quartz vessel may be plunged into water without cracking, although to every appearance it is glass. These vessels will also stand a very high heat without softening.

IN the face of many natural difficulties and keen competition of rival seaports the progress of the port of Manchester is being steadily maintained. Not the least remarkable feature of the development is the fact that within eleven years from the date of the opening of the canal Manchester has become the fifth port of the United Kingdom in respect of the value of exports and imports.

THE cost of fuel for melting brass in crucibles varies with the establishment. In brass-rolling mill practice, 3lb. of metal have been melted with 1lb. of coal. This, however, is exceptional, and the average is about 2lb. of metal with 1lb. of coal. The average brass foundry practice is pound for pound. The brass-rolling mills use hard coal for melting, and so do many of the brass foundries.

THE average production of gasoline in the United States is about 40,000,000 gallons, of which half is exported. As showing the demand for gasoline in the United States, it is stated that, in the four States of New York, New Jersey, Massachusetts, and Connecticut, there are as many automobiles as in all France, while in the United States there are more automobiles in use than in the whole of Europe.

THE three big United States cruisers now lying alongside of each other at the builders in San Francisco are rapidly nearing the finishing strokes. The protected cruiser Milwaukee will be the first of the trio to be completed, and will be ready to make her official trial runs early in April. She is an enlarged type of the Olympia, Dewey's flagship. The Milwaukee is built practically on the same lines as the Olympia.

A PAPER was recently contributed to the Academy of Sciences, Paris, on the distillation of copper by Professor Henri Moissan. Copper can be readily distilled in the electric furnace. When the vapour is condensed on a cool body a felted mass of copper filaments is obtained, presenting all the properties of ordinary metallic copper. Copper at its boiling point dissolves carbon, graphite, partly crystalline and partly amorphous, separating out on cooling.

CASTING nickel anodes in sand is usually considered the best practice. According to the *Engineering and Mining Record*, it gives an open grain, which is much desired in nickel-plating, for the nickel anode then dissolves more evenly in the nickel bath. The anode cast in a chill mould does not dissolve evenly, probably on account of the presence of iron and carbon in the anode, which cause the surface to chill. It gives a hard close "grain skin" to the anode.

THE average displacement of all warships, excluding torpedo craft, has increased successively from 3883 tons in 1899 to 4131 in 1900, 4416 in 1902, 4725 in 1903, 5010 in 1904, and 5739 in 1905, says the *Army and Navy Journal*. This shows an increase of 48 per cent. in six years, which is accounted for partly by an increased size of warships built, and partly by the "scrapping" of old-style ships, usually of small size. By this latter process England has brought her average displacement in the last year from 6293 tons to 9073.

THE deepest well ever drilled in America has been sunk by an oil company at West Elizabeth, Pennsylvania, twelve miles from Pittsburg, to a depth of 6000ft. It was started 100ft. below the Pittsburg coal vein. There was only one string of casing in the well, it being 6¼in. and 900ft. deep. At the depth of 2285ft. a flow of gas was struck, which was sufficient to make steam to drill the rest of the hole. At 5500ft. the temperature was 129 deg. At that rate heat equal to the boiling point of water—212 deg.—would be found at the depth of 9000ft.

THE report on the condition of the metropolitan water supply during the month of October, 1905, by the Water Examiner appointed under the Metropolis Water Act, 1871, states that the average daily supply delivered from the Thames during the month was 123,071,291 gallons; from the Lea, 34,107,140 gallons; from springs and wells, 56,286,581 gallons; from ponds at Hampstead and Highgate, 977 gallons. The daily total was therefore 213,465,989 gallons, for a population estimated at 6,757,320, representing a daily consumption per head of 31·59 gallons for all purposes.

THE central portion of the revolving field element of the 5000-kilowatt engine-driven alternators of the New York Subway is a steel casting stated to weigh 20 tons. The bore has a mean diameter of 37in., there being a "stepped" fit on the shaft. Each of the four steps is 8in. long, while a cored out section in the centre 10in. long makes the total length of the hub bearing 42in. The diameter allowance for the pressure fit was about 0·0067in., at which figure an end pressure of 550 tons was required to force the steel hubs into position on the shaft, says the *Iron Age*. The shafts are hollow nickel steel forgings, each having an axial hole 16in. in diameter running the full length.

THE Nobel prizes in science have this year been awarded as follows:—The prize for physics to Professor P. Lenard, of the University of Kiel, for his investigations on kathode rays; the prize for chemistry to Professor Adolf von Bäyer, of the University of Munich, for the development in organic chemistry and chemical industry resulting from his works on organic colouring matters and hydro-aromatic compounds; the medical prize to Dr. Robert Koch, for his discoveries in connection with tuberculosis. The prizes, consisting of a sum of about £7700, an illuminated diploma, and a gold medal with an appropriate inscription, were presented by King Oscar on December 10th at the annual ceremony in commemoration of the founder of the institution.

MISCELLANEA.

AT Odiham, Hants, lessons in ploughing will shortly be given in connection with the Technical Education scheme.

IN February next the Automobile Club is going to hold tests of speedometers and lamps in connection with the 1000 miles tyre trials.

A NEW strike in the South African coal area has been made within fifty miles of Lourenço Marques, near the railway, where prospecting has been going on for six months.

AN attempt is to be made to raise the hull and machinery of the first steamer to run on the Clyde, the Comet, which sank off Gourock in the early years of last century.

THE Newport Harbour Commissioners have approved a Bill to be promoted in Parliament next session with regard to the spending of £60,000 for improving the navigation of the Usk.

A COMMITTEE is considering the Portsmouth Water Company's new Bill for raising additional capital, so as to take in a wider area from which to draw water to supply the borough.

TENDERS will shortly be called in connection with the sewage disposal scheme prepared by the Huddersfield borough engineer, Mr. K. F. Campbell, and which is estimated to cost £135,000.

THE Newark Navigation Commissioners have appointed a committee to confer with the Trent Navigation Company, with regard to a scheme for improving the navigation of the river Trent to the Humber.

CORK waste has been employed for the manufacture of an illuminating gas, which has the advantage over coal gas that it is free from sulphur compounds, and does not therefore produce sulphurous acid when burnt.

WE learn that Professor Ludwig Mond has presented Cambridge University with a cheque for £1750 towards the augmentation or the endowment of the Stokes and Cayley University lectureships in mathematics.

THE cutting on the Lourenço Marques side of the Matolla River is completed, and the work is proceeding smartly, the bed of that river being already prepared for receiving the first works of the bridge which is to cross it.

AN important link in the extension of the system of distribution of electric energy by the Clyde Valley Electrical Power Company over the area throughout which it has powers was last week effected by the laying and connecting of the submarine cable across the bed of the Clyde between the power station at Yoker, on the north bank, and Renfrew, on the south.

THE statement of the commerce of the Sault Ste. Marie canals, prepared by the superintendent of canals, shows a total movement for the year to December 1st of 43,000,473 tons. There is, of course, to be added to these figures the December movement before the total of the year can be secured. This is by all odds the heaviest season that the canals have ever had.

AN excellent example of substantial workmanship is seen in the old crane at the Earl Grey Dock, Dundee. After sixty-six years' continuous work, it has only been found necessary to replace the wooden jib by a steel one. The old jib was made out of an oak tree taken from Camperdown Woods to the old Tay Foundry in 1839, and has latterly given signs of decay.

THE Copenhagen correspondent of the *Manchester Guardian* writes: It is proposed to erect a new dry dock in Copenhagen capable of holding the largest vessels trading in the Baltic Sea. The harbour authorities of Copenhagen have taken the matter up, apparently realising that the Swedes intend to make a strong bid for some of the shipping business, which at present goes to Denmark.

THE Glasgow Electricity Committee recommend that application be made for further borrowing powers to the extent of £240,000 at least. It is proposed to put down three additional turbine generators of 4500 horse-power each, as the tramways department will in course of time require all their current for tramway purposes, and will therefore not be able to supply supplementary current to the Electricity Committee.

AT a meeting of the Institution of Civil Engineers, Glasgow Association of Students, held on 18th inst. in the Institution Rooms, Bath-street, Glasgow, Mr. D. A. Matheson, M. Inst. C.E., presiding, a paper was read by Mr. R. S. G. Fowler, B.A., Stud. Inst. C.E., dealing with the construction of "Hebburn Graving Dock," belonging to Robert Stephenson and Co., Hebburn-on-Tyne, recently carried out from the designs of T. Meik and Sons, contractors, Edinburgh.

THE Chambers of Commerce Association addressed a letter to the Postmaster-General on the subject of telephonic communication with the Continent, and has received the reply that no definite information is available as regards the limit of distance by sea and land over which telephonic conversation can take place. In fact, the limit has to be determined by practical experiment in each case. The present practical limit of speech by sea lines is that between Great Britain and Belgium, which is 47 nautical miles.

THE Sunderland Town Council have decided to borrow £18,000 for extensions to the electricity station. Mr. Alderman Bruce, chairman of the Electricity Committee, stated at the last meeting that they had been very successful, and at the end of the current year they would have a net profit of £3000. The demand had increased enormously, owing to engine works and shipyards taking current for motive power. Amongst others, one firm had stated that the cost of electricity had been £300 per annum less than steam.

A CONVERSAZIONE and dance took place on the 15th inst., under the auspices of the Glasgow University Engineering Society. Mr. G. T. Beilby, the honorary president of the Society, received the guests in the main laboratory, aided by Mrs. Beilby, Professor and Mrs. Barr, and Professor and Mrs. Biles. Upwards of 500 guests attended. During the early part of the evening various machines in the laboratory were running, test pieces of iron and steel were broken in the large 100-ton testing machine, and a number of electrical experiments and demonstrations were made.

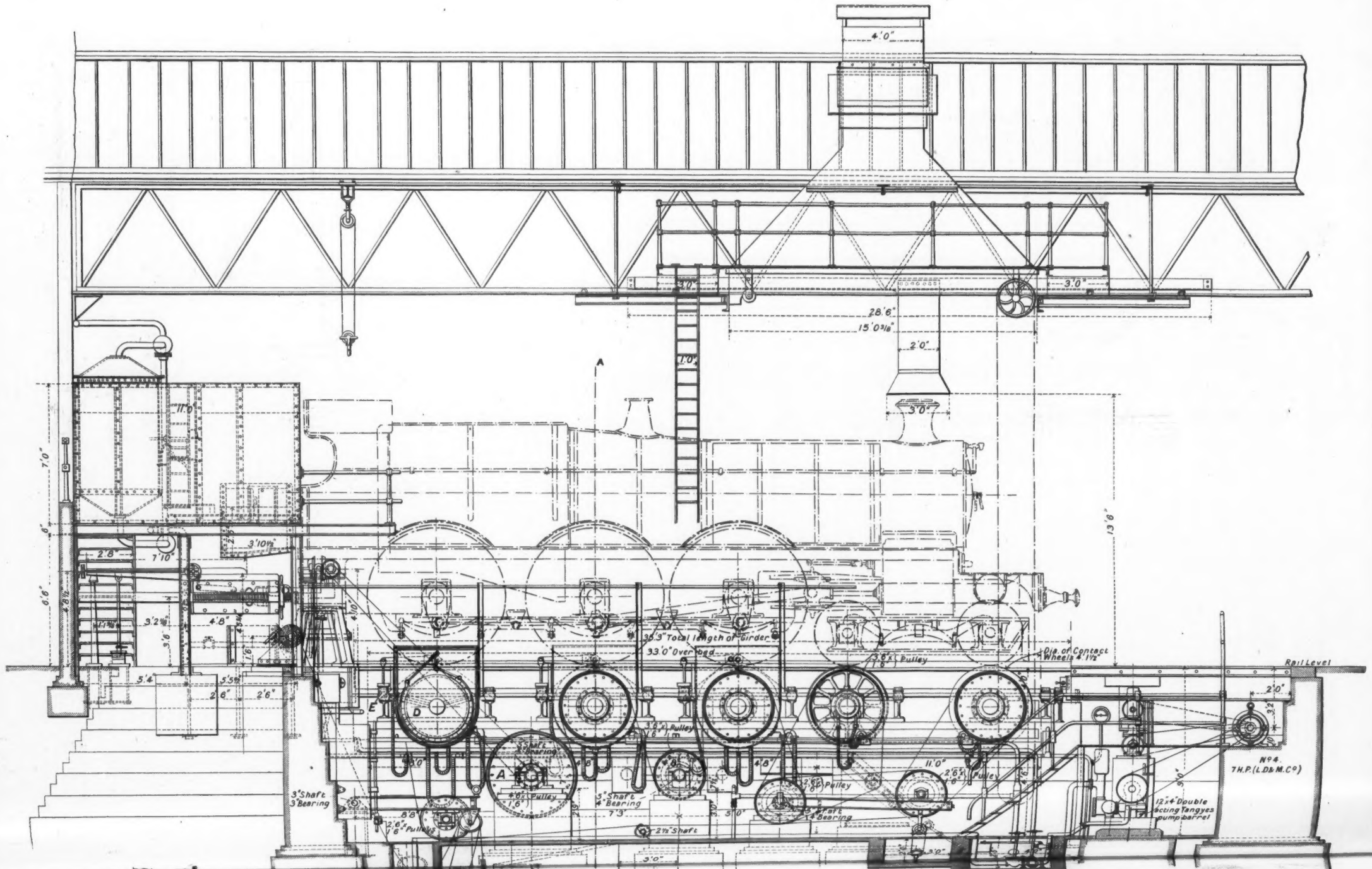
OWING to increasing contracts in England and European countries generally for oil, the Union Oil Company of California has, says the San Francisco correspondent of the *Daily Chronicle*, decided to lay an oil pipe line across the Isthmus of Panama, at a cost of about £200,000. The oil will be taken to the Pacific side of the isthmus, and pumped across through the pipe to the Atlantic side, where it will be trans-shipped. This will ultimately be considerably cheaper than paying overland freight charges to the Atlantic coast or sending by ship the whole distance.

THE latest novelty in marine transport is the projected voyage of the Dewey, a floating dry dock, from Chesapeake Bay to Manila, a distance of 14,000 miles, *vid* the Suez Canal. A tugmaster at Norfolk, Va., has just signed a contract for this remarkable cruise, says the *Westminster Gazette*. The dock, which has been built to accommodate the largest American warships in the Far East, is too big to be steered by any rudder that mechanical ingenuity can devise, so she will be held on her course by three large colliers, with a towing-line a mile and a-half in length. The cables used will be the largest steel ropes in the world, with the exception of those of some of the great suspension bridges.

LOCOMOTIVE TESTING PLANT AT SWINDON

MR. G. J. CHURCHWARD, M. INST. C.E., SWINDON, ENGINEER

(*For description see page* 621)



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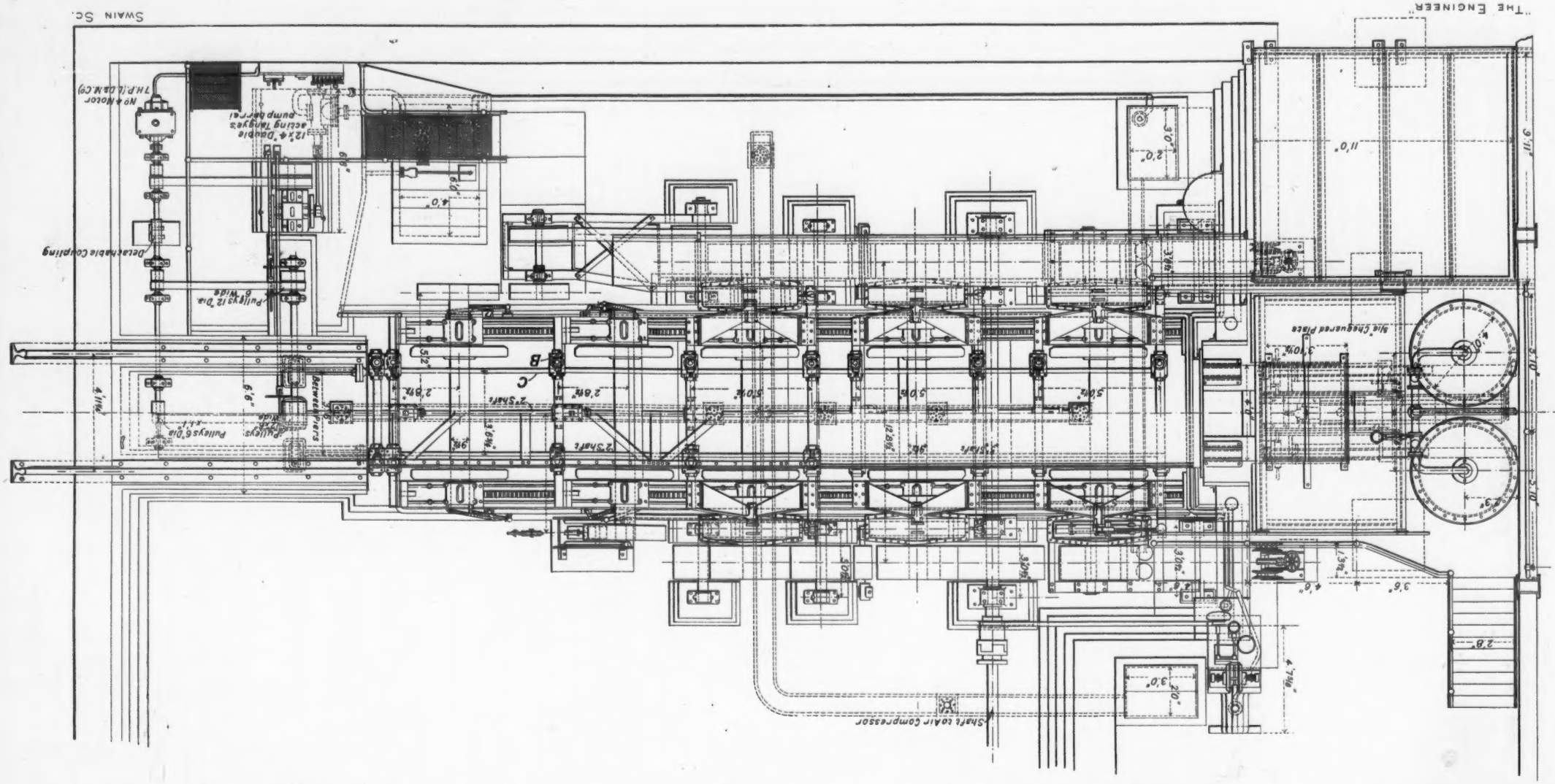

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*** *With this week's number is issued as a Supplement a Two-page Drawing of a Locomotive Testing Plant at Swindon. Every copy as issued by the Publisher includes a copy of this Supplement, and subscribers are requested to notify the fact should they not receive it.*

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☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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REPLIES.

R. G. (Crouch End).—The address of the Junior Institution of Engineers is 39, Victoria-street, Westminster, S.W.

F. A. L.—Molesworth is a standard work amongst engineers, but you will find all the information you want in your case in any one of the smaller and cheaper books.

A. D.—We cannot recall the name of any work dealing specially with forced draught, but any good book on marine boilers will give you particulars of the principal systems.

S. B.—You will find that in a large number of bridges, and in some machines having a reciprocating motion—such as those used for printing—the bearing rollers are prevented from touching one another and from moving from their proper position.

THE ENGINEER.

DECEMBER 22, 1905.

THE WEAR OF TRAM RAILS.

THE report of Mr. Fell, Chief Officer of Tramways to the London County Council, on a visit which he has paid to the United States, has just been made public. The mental result of his trip Mr. Fell has stated in a very few words, giving his reasons subsequently. The view taken in the United States is that when there is a main road out of a city—nearly all towns in the United States are called cities—or a possibility of connecting two of them, there should be a street railway to develop the district. The difference between a new and an old country is manifested by the circumstance that in most cases the financial success of undertakings of this kind is postponed until the district served develops. Speeds of as much as 50 miles an hour are maintained on tramways laid alongside the highways. Risks are incurred which would not be tolerated in this country. We are told by Mr. Fell, however, that accidents do not take place. The advantage secured is that people with moderate means can live at considerable distances from business centres. The prevailing conditions, however, are so dissimilar from those obtaining in this country that it is not safe to draw conclusions in favour of the suitability of either the English or American systems to other countries. Thus, a tramway is certain to secure traffic when it represents the only means of locomotion. On this point Mr. Fell is fairly emphatic; he writes:—"In most of the smaller cities the trackwork is of the cheapest possible character, and, apparently, this is all that is required until the undertaking is in a position to instal the work in a more permanent manner. It does, not, however, follow that the track in important cities is satisfactorily maintained. The condition of the paving in some of the cities which I visited is disgraceful, and would not be tolerated in this country. This point should be taken into consideration when comparing the operating costs with those of similar undertakings in London." We may add that the conduit system is unknown outside New York and Washington. As to working costs, it appears that the London County Council pays 7·49d. per car mile, against 7·5d. in the United States; but the accounts are not arranged in the same way. On the United States basis the London County Council trams would come out at 7·06d. per mile—a price which Mr. Fell believes will be reduced when the new generating stations are at work.

Some months ago we published an article on "Roaring Rails." The conclusion arrived at was that the peculiar noise made by a train was due to the waved surface of the rail tables. A curious light on the subject is thrown by Mr. Fell, who finds that in the United States tram rails have to be rejected after a few months' work; indeed, long before they are worn out, because the upper surfaces become "corrugated." The facts are suggestive, but in a way mysterious. In this country it has been known for a long time that the top tables of tramway rails become waved or corrugated; but no one assumed that the mischief was as serious as Mr. Fell now tells us it is. The length of the wave is 2½in. to 5in. The character of the corrugation varies with the conditions. It is usually worst on curves, when a short wave is formed on the outer rail and a long one on the inner rail. Nothing of the kind is ever found on a horse-worked road. When the Kennington, Brixton, and Streatham cable line was worked, trouble was experienced almost at the beginning. The higher the speed the greater the wave lengths. It is a remarkable fact that in Buffalo no phenomena of the kind occur. It is the only city in the United States that escapes; why, we have not the least idea. Mr. Fell regards the matter as very serious, as it will involve an enormous outlay on renewals unless it can be checked.

Concerning the cause, it is by no means easy to frame a useful hypothesis. In the United States the track is poor as compared with that used in this country. With the exception of the conduit lines, where extended yokes are used, the rails are in nearly every instance laid on wooden sleepers or ties. By this means a fairly easy riding road is obtained; but as the sleepers are not, as a rule, supported on a concrete bed, and they are not properly anchored down, there is a certain amount of spring in the track. Here very deep rails are bedded in concrete of the highest quality. The fact that the rails suffer equally in both countries goes, of course, to prove that the substructure of the road has nothing to do with what happens to the upper surfaces of the rails. Mr. Fell believes that the rails as they come from the rolls have a waved surface, due to chattering or vibration in the rolls when beginning to reduce an ingot. We do not think that any action of this kind takes place at that period in the formation of the rail where it could affect the upper surface. That that surface as it leaves the rolls is dead true no one supposes; but there is no regular wave of inequality, such as that quickly developed when the rail is used. Indeed, Mr. Fell admits that the results of tests which he has made with new rails do no more than prove that the upper surface is not smooth. History repeats itself. Brunel proposed when the Great Western Railway was made, to pass over it a car mounted with grindstones which should smooth out all inequalities and give a smooth and even surface to the rails. Brunel's scheme was never tried, but Mr. Fell about nine months ago had a water tank car fitted with long carborundum blocks passed over rails in bad order. He ground off the high spots from some rails, and it is satisfactory to add that the waves have not since reappeared. No attempt has been made in the United States in this direction. Mr. Fell holds that in all rail mills grinding apparatus should be used to make the rail tables quite smooth and true at the outset.

It may yet, we think, be found that the formation of waves is largely affected by the springs carrying the cars. These springs are continually in action, and it will be seen that they have, like all springs, a period of oscillation proper to each spring. The time will be modified by the inertia and momentum of the weight carried, just as the balance spring of a watch vibrates slower or faster according to the magnitude of the mass of the balance wheel. It seems clear that the pressure on the top of a corrugation is less than that on the bottom. That cars pitch every one knows. Thus, then, we have a rythmical action, which continually tends to augment in magnitude. This is proved by the anomalous connection existing between the wave length and the speed of the car up to a certain point. At low speeds the waves are but a few inches long; at 25 miles an hour they average 2ft. 6in.; but at 40 miles an hour, on the Boston Elevated Railway, they are still 30in. long. Yet though apparently no uniform relation exists between the speed and the wave length, some relation does obtain. The difference between 10 miles an hour and 25 miles is marked. We argue from this that the springs play an important part. The longer and easier the spring, the longer should be the wave length. The whole question demands very careful investigation. The remedy may lie ready to our hands, or may not. It is not good news for metropolitan ratepayers that the cost of rail renewals promises to be heavy to an extent never anticipated, and the expenditure of considerable sums on experiments seems to us to be not only justifiable but imperative. If the ruin of the track can be traced to small initial defects in the rail tables, then by all means let us get rid of these defects. On the other hand, it may be possible that the car, regarded as a spring-suspended vehicle, may be in fault in the way we have sketched. The whole problem of spring suspension is now being brought to the front by motor car builders, and it is not impossible that rather surprising results may be secured.

MODERN STEAMSHIP COMPETITION.

THE predominant position that is occupied by the British industry in most parts of the world has at times led to a depreciation of the merits of the steamers when the question has been raised as to the rapid growth of the mercantile fleets of other nations, and that of Germany in particular. It has even been alleged that our shipping companies are

behindhand in the internal equipment of large ocean-going passenger steamers in regard to the provision of accommodation for the comfort and convenience of passengers, and in the matter of speed of liners engaged in the Transatlantic service. Although two or three of the steamers owned by the principal German companies hold the record for speed across the Atlantic at the present time, they will be compelled to recede to the second place on the completion of the two large vessels now being built for the Cunard Steamship Company, which have been designed for a rate of 25 knots. The question of alleged superior accommodation on certain foreign-owned vessels represents a doubtful claim which it would be difficult to substantiate; but this is quite immaterial for the present, as all the advantages said to be vested in Teutonic steamers have been attributed to their modernity. It has been asserted that the Germans provide considerable sums of money every year for depreciation of their ships, and that at the end of a few years the vessels are sold and substitutes obtained in the form of new steamers of the latest types. The inference would be that British shipping companies do not know their business, and that they have to receive lessons at the hands of their most formidable rivals in the carrying trade of the world at the present moment. But such an inference is absolutely incorrect, and, in fact, there is every indication that our shipping companies are fully alive to the necessity of moving with the times, and, if possible, of outstripping their strongest competitors.

The appropriation of considerable amounts out of the profits every year for the purpose of depreciation of the steamers would appear to be the foundation for the ability of the principal German shipping companies to have modern fleets by the disposal of comparatively old vessels and the introduction of new steamers in their place. But is not precisely the same policy followed in Great Britain, although it has, perhaps, not received such a large amount of attention? If we turn to the accounts of the Hamburg-American Steamship Company for 1904, we find that with a fleet represented by 764,000 register tons the amount written off for depreciation was £723,000, whereas the Peninsula and Oriental Steam Navigation Company made a similar provision of £536,000 for 1904-05 with a tonnage of 366,000, or less than half that of the Hamburg line. The amounts for the past two years are £1,280,000 in the case of the German company, and £1,036,000 in that of the English company, while the figures for the North German Lloyd Steamship Company, with a tonnage of 507,000 at the end of 1904, are £640,000 for depreciation in 1904, and £680,000 in 1903, being a total of £1,320,000 for the two years in question. Next to these Teutonic lines comes the Hansa Steamship Company, which does not make a practice of disclosing the allowance for depreciation, and which has for several months past been engaged in a freight rate war with the Peninsula and Oriental and British India lines. The amount provided for depreciation by the Hamburg South American Steamship Company in the past year was £129,000, the German East African Line appropriated £80,000 for this purpose, the German Australian Company £72,000, and the German Levant Steamship Company the sum of £31,000. As contrasted with these allocations by the leading Teutonic lines, we note that in the past year the Pacific Steam Navigation Company made provision for depreciation to the extent of £175,000, the Cunard Steamship Company £139,000, the Royal Mail Steam Packet Company £87,000, the Anchor Line £70,000, the Indo-China Steam Navigation Company £64,000, and the Orient Steam Navigation Company £48,000; whilst the sum provided by the Union-Castle Mail Steamship Company is apparently not generally known outside directorial circles.

Any comparison of the amounts written off for the depreciation of vessels by British and German shipping companies might lead to erroneous conclusions if due regard were not paid to the total capital invested in each particular business, or, at all events, to the book value of the fleets in the accounts of the different shipping undertakings. As information as to the total share, debenture, or loan capital is not readily ascertainable, a contrast of the percentages provided for depreciation in relation to the book value of fleets is not only desirable, but is likely to be more strictly accurate. As examples may be cited the Hamburg-American and North German Lloyd Companies, which show for the past four years an average of 6½ per cent. and 3½ per cent. respectively for depreciation, but the proportion in the former case would not be quite so large had it not been for the large profits realised from the sale of steamers owing to the late war in the Far East. The Peninsula and Oriental Company has, as a general rule, allowed 5 per cent. for depreciation, but this is becoming obsolete, as considerably extra amounts have been provided for this purpose in the past few years, which compare very favourably with the best of the two principal Teutonic companies. We believe, that regarded from the percentage point of view, the other important British shipping companies may be contrasted satisfactorily with any of the German companies, and we must, therefore, conclude that the former are fully as progressive and far-sighted as the latter, more especially as new British ships are placed in service with perhaps less ostentation than those of competitive nations, whilst, at the same time, less is heard of the disposal to other countries of the comparatively modern vessels weeded out of the fleets of the principal British lines than is the case in regard to similar transactions in other countries.

THE DOMESTIC HEARTH.

IN summer no one thinks of the domestic hearth, its virtues or its crimes; in winter it excites a great deal of attention. The householder grumbles at the coal merchant. The smoke abatement men denounce the fireplace; is not the domestic hearth responsible for the iniquitous fogs which plague great cities? Discussions on smoke abatement we have always with us in the winter; their inutility is distressing to right-minded persons. "Why," they say, "should men like Sir Oliver Lodge talk and talk, and effect nothing?"

The answer to the question seems to us to be easily given. The experience of a century or so proves that it is impossible to burn bituminous coal in any open grate without the production of smoke at some period of the day. Nothing can be done to prevent smoke from being produced when fresh coal is put on a fire. It has taken many years to beat this truth into the head of the smoke abatement enthusiast. It is only now that he is learning that denunciations of the average builder's "stove" represent so much wasted energy and useless talk. One stove seems to be just as good and as bad as another. The attack in future must be made not on the stove, but on the individual using it. Eliminate the domestic hearth and you get rid of its black smoke. Let it not be supposed that the substitution of anthracite or coke for bituminous coal would do much good; they are both quite unsuitable for domestic use in a regular way, and they give off sulphurous acid and carbonic acid to sting our eyes and destroy books and furniture, even if smuts are suppressed. Which of us has forgotten the atmosphere of the Metropolitan Railway, wherein nothing was burned but smokeless coal? The men and women of this country love the open fire, warming by radiant heat, and it is fighting against fate to attempt to supersede it. It remains to be seen if anything can be done in the way of washing smoke. Experiments carried out some years ago at South Kensington and elsewhere were quite successful up to a certain point; and there is no mechanical difficulty in collecting all the smoke from a group of flats, or a public building or a large hotel, and so treating it that it will no longer do much harm when sent into the air. But this system cannot be applied to small houses; and, in any case, it is expensive, and requires constant attention to keep it working properly. So soon as the open coal-burning fireplace is abandoned as hopeless, and the prejudice of the Londoner is accepted as the most powerful factor in the whole business, effort will take another direction, and some improvement will be effected. Close stoves, steam heating with radiators, and various other devices take no hold here, because the weather is never sufficiently cold to render them necessary. In a really rigorous climate the open fire must either be discarded altogether or else supplemented by steam or hot-water heating. An excellent example is supplied by the great American liners. In the saloons, smoking-rooms, and library large open fires are to be found. But they are supplemented by miles of steam pipes laid under perforated plates all along the alley ways. In London, however, where auxiliary heating is used to some extent, the open fireplace or domestic hearth works on the whole sufficiently well to retain its ancient and well-established popularity. Obviously, the sensible course is to accept the inevitable, and render the open hearth smokeless. This result can only be attained in one way, and that is by substituting gas for coal as a fuel. There ought to be no mistake made about this. No smoke means gas fuel and nothing else. The average householder and the average housemaid will have nothing to do with anthracite or coke. The latter may be used, and is used to a limited extent, in the kitchener. The former cannot comply with the wants of the consumer in any form. Only enthusiasts will burn a fuel that requires about two hours to make a useful fire, and will ruin a grate in a couple of months by the intensity of its localised heat. In gas there lies the hope of the future. It admits of being burned in a way that fairly resembles the common coal fire, and it is not at all impossible that the resemblance can be materially increased. Inventors of gas fires have done not a little in this direction of late years that is highly meritorious, but much remains to be effected. Let us consider on what lines they should work; what are the prominent defects of the gas fire as it is?

In the first place, we have noise, which appears, so far, to be inseparable from the gas fire. In all cases a Bunsen burner is used, and the noise seems to be due to the rush of gas. But if a gas fire is turned down low, the burner, if properly made, will not strike back, and there is no noise. Is it possible that a similar silence cannot be secured when the fire is turned up? Large Bunsen burners can be used in the laboratory without noise; why should not the same statement hold good of our gas fires? The system of putting a burner into the bottom of a grate and then filling the grate with fireproof lumps has nothing to recommend it but the fact that a passable imitation of a coal fire is secured. The flame is apt to "strike back"; then the burner is choked with soot, and there is waste and no heat. The burners ought to be perfectly accessible, so that they can be cleaned every morning. An example of this was to be found at the Exhibition in Vincent-square last week. Again, something much superior to the fireproof "lumps" ought to be available. Can nothing be devised by the makers of fireclay goods which will stand being raised nearly to a white heat without crumbling into dust? Has any serious attempt in this direction ever been made, save the perforated tubes of one patentee? We can do no more than indicate a few of the improvements which are vital to success.

But even though gas could be burned to perfection in such a way that a cheerful domestic hearth would be secured, there is no possibility of entirely dispensing with solid fuel until the cost of gas has been very much reduced. If only gas could be got for 1s. per 1000ft., an enormous increase in consumption would take place. Even at its present price the use of gas for cooking is extending at such a rate that it is estimated that as many as 800 cooking stoves per week are being supplied by the gas companies in London, worked on the penny-in-the-slot principle. The introduction of the mantle has rendered the world almost independent of quality so far as light is concerned, and the removal of legal restrictions on the gas companies might be followed at once by important reductions in price. This is the direction in which the apostles of smoke prevention ought to work. If they will realise that it is vain to hope that solid fuel can be burned on the domestic hearth without smoke, and that the open fire must be retained, they will also understand that gas fuel is to be the fuel of the future if smoke is to disappear. They will then concentrate their efforts on the improvement of the gas fire, bringing about legislative changes which will give London cheap gas. It is not only possible, but probable, that they will not meet with success at once; but, at all events, they will have the consolation of knowing that they are not in pursuit of a chimera, but of a quite practicable reform.

PROGRESSIVE EXPORTS.

EIGHTEEN, nineteen, twenty-one. This, in millions sterling, represents the progressive value of the export trade in engines and machinery, combined, during the first eleven months of the past three years. To be exact, the figures are:—1903, £18,215,586; 1904, £19,139,360; 1905, £21,140,838. The trade progress which these totals disclose cannot fail to be eminently gratifying to the engineering industries. Of the foregoing aggregate of 21 millions, machinery can be credited with the splendid total of 15 millions, leaving somewhat over five millions for engines. Mechanical engineers may be congratulated upon having made shipments to the value of over 6½ millions of miscellaneous machinery so far this year, or more than one million sterling better than for either of the two preceding years. This fact is very significant of the increased favour in which machine-tools of British manufacture are being held abroad, and especially in the various European countries, with which nearly a third of the trade under this heading has been done. There have been large increases with South America, and there have been augmentations also in the trade with India and the United States, and although the transactions with British South Africa and Australia so far this year have not come up to the level of a year ago, yet there is plenty of evidence to show that just recently trade with both those

countries has largely improved. Textile engineers will be pleased to see an improvement of half a million sterling on last year, bringing the now eleven months' total to over five millions, the increase being chiefly due to India, Europe, Japan, and the United States, all of which markets have taken such machinery more freely. The trade in mining machinery is still below par with South Africa—and, indeed, with most of the other countries—as regards the eleven months' period, but the statistics for the single month of November afford gratifying evidence of recent recovery, there being an advance from £16,450 for November, 1904, to £28,940 for November, 1905, and it is sincerely to be hoped that this recovery will become more and more pronounced. Agricultural engineers have every reason to be satisfied with the progress which their department shows with most of the usual markets so far this year, including Europe and South America, though there is plenty of leeway still for Australia to make up compared with a year ago. The two millions' worth of foreign business transacted by locomotive engine builders—which is about half a million better than a year ago—has been due mainly to a very large trade with India and South America. Railway construction and extension in those two countries has resulted, indeed, in some splendid orders, trade with South America having more than doubled—the eleven months' increase being from £336,000 last year to £685,000 this year; whilst the growth of shipments in the case of India has also been very marked—from £474,000 to £745,000. It is a somewhat singular coincidence that the shipments of railway carriages and wagons (£1,814,211) by approaching two millions sterling has been almost as valuable as those of locomotive engines. This carriage and wagon total is £38,000 better than a year ago, and the rolling stock makers continue very busy. It is pleasing to be able to reflect that the improved foreign trade which has been experienced in all branches of the engineering trades since January has been coincident also with a revived home trade. Certainly 1905 is going out well, and the prospects for 1906 are, we are glad to know, excellent.

MOTOR CARS AND PATENTS.

OUR special representative at the Paris exhibition of motor cars calls attention to an extraordinary state of affairs that has arisen in the French motor car trade. Whilst builders were as busy as they could be supplying the market, they took little or no trouble to see that their patent rights in invention were respected; but now that competition has increased to a point where every advantage must be seized and held fast, those engineers who some years ago secured patents which have by degrees come into general use are bethinking themselves of insisting on their rights, and restraining other makers from employing their inventions. A test case that is spoken of is an action by the Mercédès Company against another firm for the infringement of the Maybach carburretter. If this case is successful, not only may it itself have a wide influence on the trade, but it will unquestionably lead to similar actions—indeed, such a generally used device as the direct drive is likely to come before the Courts. It is needless to say that the matter cannot begin and end in France. The French makers hold many British patents, and the possibility of pressing their claims in this country will not escape their attention. The result, if the patentees relentlessly pursue their claims, is likely to be interesting, if not exciting. Not only could they prevent the further manufacture of their inventions, but they, unless some satisfactory arrangement was arrived at with the makers, might even "hold up" all cars already fitted with these inventions unlicensed by the owners of the patent, since a person who merely uses something which is an infringement is liable as an infringer. It is thought in some quarters that if a patentee has failed for a number of years to take action to prevent infringement he forfeits his right to do so. We are advised that such is not the case. As long as the patent has not been allowed to lapse, the patentee has a right to restrain other persons from making, selling, or using his invention. With the knowledge that it may spread to this country, the progress of the action in France will be watched with close attention.

RAILWAY CONTRACTS FOR YORKSHIRE COAL.

ALTHOUGH it is believed that had the Yorkshire coalowners remained firm, their quoted rate of 8s. 9d. per ton for the year 1906 would have been secured, considerable satisfaction is expressed that an advance of 3d. per ton has been obtained, making the rate 8s. 6d. per ton for the whole year. The forecast given in this journal at the beginning of the month has been verified, as the coalowners, at a meeting at Leeds on Tuesday, accepted the offer of the North-Eastern Company of 8s. 6d. per ton for the twelve months. It is known that the various railway companies have been in touch with each other, so that it is more than probable that the action of the North-Eastern Railway Company will rule the other companies which use the best South Yorkshire hards. The coalowners present at the meeting pledged themselves not to accept any lower price, intimating that they would rather stack the coal than do so. It was pointed out that there were unmistakable signs of an improvement in trade, and as 6d. per ton advance has been secured for coal for shipment next year, it is believed the North-Eastern Railway Company has made a good bargain. There can, however, be no doubt but that such contracts as those just made with the North-Eastern Railway Company are most desirable possessions. It may be stated that the company consumes in round numbers a million tons per annum. During the first half of the present year, with an advantage of 3d. per ton compared with the first six months of 1904, a saving of nearly £11,000 was effected. The contracts, if placed at 8s. 6d. per ton all round for the year, will mean that the company's coal bill will next year be increased by something like £20,000. The North-Eastern Company has always been good to deal with; in the never-to-be-forgotten year 1900, when 16s. per ton was paid, the company, together with the Lancashire and Yorkshire, was the first to accept the high rates imposed.

LOCOMOTIVE TESTING PLANT AT SWINDON.

NEW locomotives, and those which have undergone heavy repairs, always make trial runs before they are put into regular service. The object of these preliminary tests is too obvious to require explanation. It is not easy, however, on crowded lines to get a clear road, and delay and inconvenience result. Some years ago it was resolved that the Great Western Railway should have a testing plant resembling in its general features that at Purdue University. The requisite drawings were made, but nothing more was done until the early part of the present year, when the apparatus was completed. A general description of it appeared in our issue for April 22nd. By the courtesy of Mr. Churchward, chief mechanical engineer of the line, by whom the machinery was designed, we are now able to publish drawings and photographs fully illustrating the plant.

Before proceeding further, it is well to explain that the brakes are not used in any way as dynamometers. The only measurements taken are the speeds in miles per hour, the draw-bar pull, and indicator diagrams. Even these last are only taken when a new engine or new type of engine is tested. The principal use of the apparatus is to run engines to get all the bearings right, and at this work it is very fully employed. But as will be seen, careful provision has been made for the utilisation of the machine for what may be called higher scientific investigation. The water can be measured and coal weighed, so that with indicator diagrams, draw-bar pull, and coal and water measurements, all the particulars necessary to ascertain economical efficiency are available. Furthermore the accuracy, or the lack of it, of balancing can be ascertained in a way that will be obvious before we have done.

There is a large brick-lined pit in a special building. It is proposed ultimately to put down two more testing plants, so heavy is the work now at Swindon, and space enough has been provided for the purpose. Across the mid-length of the pit is a bed made of cast iron, bolted on a concrete foundation, with timber baulks interposed for the lessening of vibration. On this bed five pairs of bearings are arranged to slide longitudinally, so that they may be adjusted separately for any wheel base of the engines tested. In these bearings axles are carried, having wheels a little over 4ft. in diameter, fitted with steel tires, on which the locomotive runs. These axles are also fitted with drums on which band brakes act for absorbing, wholly or in part, the power of the engines. It is essential that the bogie and trailing wheels of engines should be run, as well as the driving wheels, in order that the axle-boxes may take a good bearing, and be seen to be in a satisfactory condition before handing the engine over for traffic. To accomplish this the carrying wheels are all coupled together by a suitable arrangement of belts and jockey pulleys. It therefore follows that even when a locomotive having a single pair of driving wheels is run on the plant, all the carrying wheels are rotating, and in turn run the bogie and trailing wheels of the locomotive. The jockey pulleys are necessary to retain the proper tension on the belts when the bearings are moved longitudinally. The arrangement of these belts is very well seen in the engravings, page 617. It required much consideration, and the belts are hardly tried, with short lengths, many bends, and driving on both sides.

In order that power may not be wasted, one of the shafts marked A in our Supplement rotates a pulley carrying a canvas belt about 2ft. wide, which drives on to the fly-wheel of a double-cylinder air compressor standing on the concrete floor of the pit. The air is used in the shops for pneumatic tools.

We may now proceed to describe the mechanism more in detail.

The engine is brought on a traverser opposite a pair of large doors, through which it enters, and is run in on the flanges of its wheels bearing in grooves on the table before mentioned. The table is carried on sixteen screw jacks, with brass guide plungers, and a stroke of about 3in., eight at each side. One of these is shown at B in the plan, in our Supplement. The screws are fitted with bevel wheels, which gear in similar wheels on a lay shaft C. This shaft is actuated by the motor shown at the end of the pit. With these jacks the engine is lowered on to the carrying wheels, or lifted off them.

Two heavy racks are provided in which gear wheels, driven by a lay shaft and motor, by which the carrying wheels can be shifted, to suit different wheel bases of locomotives, by means of a clutch on a lay shaft, and the frames with the bearings can then be fixed by lock bolts. It is a matter of most vital importance that the wheels of the locomotive shall stand in a vertical line precisely over the centres of the carrying wheels, and to secure this has been one of the most difficult problems attacked in designing the plant. Turning to the elevation, one of the strap brakes is shown at D. Load is obtained by small hydraulic presses, one of which is shown at E. It will be understood that the action is upward, not downward as if a weight had been used. Pressure is obtained from the double-acting pump, shown very clearly in both the plan and elevation, and driven by belting from the motors. The pump works on the flow and return system under a loaded valve. The outlet is throttled by a valve actuated by a centrifugal governor standing near the edge of the pit. It can be regulated by hand for any particular speed, and it augments or diminishes the brake load so as to keep the speed constant within certain limits. It acts, however, more as a regulator securing uniformity, than as a speed controller. A water service for the brakes is provided. The flexible hose pipes are clearly shown in the engraving.

At the side of the pit is placed a system of levers and a steelyard, by which the draw bar pull can be measured. This is shown at F, page 621. The small handle is for racking in and out the fly weight on the steelyard. The two capstan wheels are attached to nuts working on two powerful screws, which can be brought to bear on the back headstock of the engine to check vibration. Just above this gear will be seen the two water measuring tanks. In the position of the coal bunker opening of a tender is fitted a weighbridge box, by which the consumption of coal can be ascertained. As engines of different lengths are to be tested, and of necessity have to be fixed at the trailing end to the dynamometer, it is necessary to have a sliding chimney for carrying off the steam and smoke from the engine when running. This has been provided in the form of a long box, having a steel plate running on rollers forming its lower surface, which plate carries a large bell-mouthed chimney. This box not only enables the chimney to slide longitudinally, but also forms a receptacle for ashes and any other matter ejected by the engine, which can be retained, and can be examined both for quantity and quality.

We have now said enough to make the general construction of the machine clear, but nothing but an inspection of it could convey an adequate idea of the numerous difficulties which have been successfully overcome.

At the time of our visit, the Malta, a fine express engine of the 4–4–2 type was being tested. The engine was just out of the shops after a thorough refit, and was run at various speeds, a stop being made to find hot bearings should they exist. They did not get sensibly warm. It does not fall to the lot of many engineers to stand beside a four-coupled engine running at 70 miles an hour, and the sight is not easily forgotten. Coupling rods at over 300 revolutions per minute tend to appear as streaks, and we dare not venture to ask ourselves what would happen if one broke. Again, the engine is held in place by the draw-bar. If that gave way what would happen? As, however, a draw-bar pull of something over one ton is considered good duty at 70 miles an hour, representing as it does nearly 500 horse-power net, there is not much danger. When we have become a little reconciled to the deafening roar of the wheels, and made up our minds that nothing is going to fly to pieces, we can begin to learn things. In the first place, we see that the bearing springs of the engine have no movement; this is because the locomotive is virtually running on a perfectly smooth and rigid road; there is no rolling or pitching. We have, in fact, nothing but the internal disturbing forces to act. These assert themselves by a tendency to fore-and-aft oscillations, not at all marked at 40 miles an hour, not even at 55 to 60 miles an hour, but becoming so violent at 70 miles an hour that the screws pressing on the back headstock mentioned above are evidently absolutely necessary to steady the locomotive. Without them, indeed, no speed much over 45 miles an hour would, it seems to us, be safe. This end-long movement is due to the want of balance in the reciprocating portion of the machine, and the continual variation at each revolution in the line of thrust, according as the forward pull of the engine is due to the pressure on a cylinder cover or a driving axle-box. When the steelyard is in use, the steadying screws are slacked back sufficiently to leave the draw-bar free of the tension which they might otherwise set up in it, and so falsify the reading.

But perhaps the most interesting feature is the performance of the leading bogie, which is in comparatively violent motion. Although the cylinders are inside, it is evident that the engine tends to "box," and throw the bogie right and left. Here, again, the movement increases very rapidly with the speed. At these enormous velocities of heavy moving parts, the whole machine seems to be alive, and we can very well understand that no one cares to run an engine being tested up to 80 miles an hour, while 60 is considered quite sufficient for all useful purposes. The whole performance is exceedingly instructive, showing as it does how an engine behaves when all the external disturbing forces due to the road are eliminated, and if time should be found to

investigate this matter, much that is valuable as to the influence of various forms of construction, and disposition of balance weights might be learned, and would serve to confirm or disprove the accuracy of views advanced by those who have mathematically investigated the questions at issue. It is not that calculations may be wrong in principle or in method, but that practical data may be lacking which the Swindon testing plant would supply.

In conclusion, we wish to express our thanks to Mr. Churchward for the drawings and photographs which he has placed at our disposal, and to Mr. Collett, his assistant, who spared no trouble in explaining to us the construction and action of a machine which is, we know, the only one in Great Britain, and, we believe, at this side of the Atlantic. In the United States there are two, one made several years ago for Purdue University, and the other the property of the Pennsylvania Railway Company. They both differ from the Swindon plant.

It is pleasant to add that the splendid shops at Swindon are full of work, over 13,300 hands being employed, some on overtime.

LITERATURE.

Baku: An Eventful History. By J. D. HENRY. With many illustrations and a map. London: Archibald Constable and Co. Demy 8vo. Pp. xviii. and 256. 12s. 6d. net.

IT is a strange fact that every now and then one of thousands who visit Baku discovers that he is the only European who knows anything about that place. These individuals are generally happy in possessing, in addition to this marvellous discernment, an unselfish nature, so they set to work to enlighten the ignorance of the Western by writing about what they have seen and learnt. The present author is no exception to the rule, for he has recently been to Baku, and he informs his readers that twelve months ago the man who knew nothing about oil was ignorant of Baku. He therefore sets himself to work to re-tell the history of Baku, and the rise, progress and development of the oil industry, and he does it very well, producing a readable and interesting account. As is usual with the visitor to Baku, he goes into ecstasy over the spouters, and he regards them as too good to be disposed of in one chapter, so not alone distributes them adventitiously, as it were, about the book, but allots to them two chapters all to themselves, separated by other chapters of less exciting nature. He certainly has encountered at least one marvellous spouter, 10½ft. in diameter, which rose to a height of 200ft. But spouter stories somewhat resemble fish stories in their uncertainty. There are many points of interest in the book; among them, for instance, it is shown how an opportune imposition of an import duty—page 37—arrested the importation of American oil, the imports falling in eight years from about 40,000 to 7419 tons, and so fostered an important home industry. On the other hand it is shown elsewhere how Government restrictions can hamper an industry in spite of the efforts of men of genius, and what a remarkable change was effected under the sway of these men when the restrictions were removed. The wonders the Nobels performed are frequently referred to; in a quarter of a century they drilled some 500 wells of an aggregate depth of more than 100 miles, and extracted from them from 19 to 20 million tons of oil. Again the glorious uncertainty of the value of oil-bearing lands is shown and frequently demonstrated. On page 53, for instance, a lot valued at £57 by the Government was bought for £906, sold to an English company for £600,000, and within a month after the purchase developed a spouter which yielded oil to the value of half its purchase price. The developments in treatment and transport of the oil are duly considered; a good instance of growth is recorded in the Caspian Sea oil traffic. In 1894 there were 66 tank steamers of a capacity of 1,992,947 cubic feet; in 1904 there were 134 tank steamers plying in that sea, capable of carrying 5,328,094 cubic feet. But the most astonishing portions of the work are those recording in a vigorous and vivid manner the appalling scenes and deeds enacted during the recent rising in the Caucasus. The book is not technical, hence only a little over a page is devoted to the subject of drilling; but it contains a lot of useful information, which, moreover, is presented in an agreeable and creditable manner.

SHORT NOTICES.

Motor Vehicles for Business Purposes. By A. J. Wallis-Tayler, A. M. Inst. C.E. London: Crosby Lockwood and Son.—This is claimed to be a practical handbook for those interested in the transport of passengers and goods. The subject is one of considerable importance at the present time, and a book which deals in a thorough manner with it should meet with ready acceptance. We cannot say, however, that this work fulfils the expectations held out in its title, as several of the vehicles shown are already obsolete, while other important systems which occur to us are not included. Chapters II. and III., dealing respectively with the resistance to traction on common roads and the power required for motor vehicles, are chiefly a collation of the theories and experiments which have been carried out by well-known authorities on the subjects. They form the most interesting and useful portions of the book. The author might with advantage have given further information on the subject of tires, which is of no inconsiderable importance. The descriptions of the vehicles contained in the book, too, are strangely uneven. Some makes are dismissed in a few lines, while others are described at considerable length. The section devoted to the lighter commercial vehicle is very scantily treated, while the effect of materials on the cost of maintenance is dismissed in the most perfunctory manner. Not many users or intending users of motor vehicles, we should imagine, need to be told that steel enters largely into their construction for crank-shafts, axles, springs, hollow shafts, tubes for framework, but some would like to know when the use of cast steel is permissible, for instance. Aluminium and its alloys are not mentioned.

Handbook on British Patents for Inventions. London: Day, Davies and Hunt, 321, High Holborn. Price 6d.—This is an elementary and simple statement of the procedure necessary to obtain a patent. It is intended for amateur inventors. It perhaps lays too much stress upon the desirability of a search, but otherwise we find it free from technical errors, saving that the Privy Council has nothing to do with ordinary suits for revocation, as is stated on page 14.

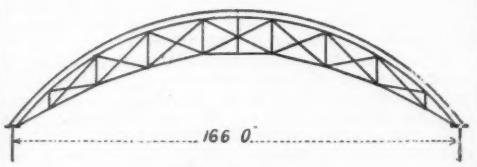
CHARING CROSS ROOF.

IT will be of interest, perhaps, if we put on record the principal facts elicited at the resumed inquest held on Monday last on the men who lost their lives by the falling of Charing Cross roof. Apparently the time which elapsed between the first signs of anything being wrong and the actual collapse must have been some fifteen minutes. During that time that portion of the structure which eventually fell was gradually sinking inch by inch. The sagging began, according to one witness, about 40ft. from the end of the roof. Before the actual fall several cracks were observed in the station wall in the second bay from the end, and chiefly near the buttresses. Then the main girder next the wind screen collapsed; the wind screen itself fell inwards towards the station. Practically at the same moment the west wall collapsed; in fact, according to one witness, the wall gradually bulged till it fell over, causing the final collapse of the roof girder.

According to the bridge foreman of the railway company, the work of repairing and repainting the roof has been in progress since the beginning of July. Starting at the south end of the station, the first section had been completed inwards, and when the accident took place the necessary staging had been erected for dealing with the next section. The staging was 35ft. wide, and extended right across the station, half being on one side of the first main girder and half on the other side. Its weight was taken by the cross girders. His duty was to see that the old paint was properly burnt off, and the iron scraped and cleaned. He personally inspected the ironwork and reported any appearance of corrosion to the engineer in charge.

He had not examined the tie-rod which failed before the accident, and no part of the staging was attached to it. Five iron bracings had been discovered to be corroded in the first section of the roof, and had been replaced. Probably a ton of zinc was lying on the roof at the time of the accident. It was nine years since the interior of the roof had been painted, and two coats were then applied.

Two-thirds of the fractured surface of the broken tie rod showed corrosion, pointing to ancient fracture. When the tie rod broke there was a loud report. A hurried examination made immediately afterwards, and before the roof fell, showed that one of the cross braces connecting the first principal girder with the tie rod was cracked almost in the centre. An attempt was made to support the tie rod with ropes. The broken tie rod was seen hanging down before the roof fell by several witnesses. No expert evidence was taken, and will not be till January 8th, to which date the inquest is adjourned.



CHARING CROSS ROOF

It may help our readers to a better understanding of the accident if we give a diagram drawing of the roof. Each principal consists of a wrought iron main plate girder or rib, the web of which was originally ½in. thick, and bracing consisting of eight vertical struts dividing the truss into nine panels. The seven principal panels are provided with diagonal ties and a tie rod made up of nine straight lengths, the ends of each length being attached to the bottoms of the vertical struts by screwed coupling boxes, completes the panels at the bottom. There is an additional strut dividing the centre panel vertically in halves. The tie rod which broke was the third from the west side. It had a diameter of 4½in. The east side of the roof was fixed, and expansion and contraction provided for on the west side by means of a suspension-link saddle. It is extremely difficult to say exactly what portion of the roof gave way first, and until there is more evidence to go upon it is impossible to form a sound opinion. Certain it is, however, that supposing the tie rod itself alone broke in the first instance, this would be enough to account for what happened. We are inclined to think, however, that it was not the main tie rod which fractured first. The evidence at the coroner's inquiry would seem to indicate that a diagonal tie snapped first, and permitted a stress to fall on the tie rod, which ultimately broke it. The facts may be made much clearer when the expert evidence is obtained.

It is now stated that at a meeting of the South-Eastern and Chatham Railway Company's Managing Committee, held on Wednesday, a report from the consulting engineers, Sir Benjamin Baker and Sir John Wolfe Barry, and their own engineer, Mr. Tempest, was considered and adopted. This recommends the removal of the existing roof and the substitution of a roof of a more modern type, and placed at a lower level. As a measure of precaution while the removal of the roof is being carried out, it is recommended that the feet of each principal should be connected together by means of steel hawsers. It is estimated that these works will occupy some six or eight weeks, and the Managing Committee look forward to the re-opening of the station in February next. The design of the new roof will be such that any future widening of the station will be facilitated.

FRICTION AND LUBRICATION.

THE second lecture on "Friction and Lubrication" was delivered on Monday evening, the 11th inst., to the members of the Bradford Engineering Society in the Public Hall of the Technical College, by the president, Professor G. F. Charnock, A.M.I.C.E., &c. The chair was occupied by Mr. H. W. Morley, M.I. Mech. E. The previous lecture dealt mainly with the laws of friction and of the experimental research which had led to their determination. In indicating the direction in which these laws may be applied in practice, the lecturer first gave a brief explanation of the desirable properties and defects of lubricants, dealing with the methods of examination both by chemical and mechanical means. The various types of oil testing machines were described and illustrated, and it was shown that, if properly used in the hands of trained experts, they were capable of giving considerable information as to the value of a lubricant for any particular purpose. With regard to laboratory testing of oils, it was essential that the results obtained should be properly interpreted, and this required much skill and experience. In actual practice special machines were in regular use by railway companies, large millowners, &c., with the best results, and several of these, mostly of American origin, were next described. An interesting portion of the lecture dealt with the experiments which it was found necessary to carry out in connection with the design of the electrical machinery, rolling stock, &c., specially made by the Allgemeine Elektricitäts-Gesellschaft for the celebrated high-speed trials on the Berlin-Zossen Railway, when a speed of 125 miles an hour was reached. It was found that the previous experimental data were incapable of affording sufficiently accurate information for the purpose of preparing the designs for new machinery to work under abnormal conditions, and it was necessary to carry out, at great expense, a very extensive series of trials, the chief results of which were included by Professor Charnock in his lecture, and were keenly followed by an appreciative audience.

The method of testing a complete plant to obtain the comparative efficiency of lubricants under actual working conditions was next discussed, the full efficiency test of a textile mill being taken by way of example. The lecturer showed that the method adopted is simply an elaborate growth of the laboratory tests upon a scientific machine; in fact, the entire mill becomes the machine tested. In a textile mill the frictional losses are very large—sometimes amounting to more than half of the total power developed. For economical working it is, therefore, absolutely necessary to ascertain and make use of the most suitable lubricant for the purpose. It is, undoubtedly, the correct policy to employ the best lubricant, without reference to price, although it does not follow that the highest priced lubricant is necessarily the best. The great point is that if the cost of oil in any case does not exceed 2 per cent. to 3 per cent. of the cost of fuel, and if a reduction of, say, 10 per cent. to 12 per cent. may be made by using a more suitable oil, the matter is one deserving of the closest attention by all users of power. A test should first be made for the purpose of ascertaining the exact total load upon the mill under actual working conditions with the oils in use. This is done by very carefully indicating the engines, indicators, fitted with electro-magnets connected in series, being applied to each end of each cylinder, so that by pressing a button all instruments may be started simultaneously, thus enabling diagrams to be taken, which show the exact amount of work done at that moment by the engine. Diagrams are taken in this way at intervals of about five minutes, the total number of cards per day amounting to from 300 to 1500. A complete record of speeds, temperatures, &c., is tabulated at the same time. From two to five days' test is required to give sufficient data from which to obtain an absolute average of all the working conditions of the plant. After securing this basis, the oil originally in use is gradually displaced, and the new lubricant introduced in the regular routine way of oiling up, without any cleaning or other change being made. After a period of use, to allow the new oil to settle down to its work, an exact duplicate test is made, working to the same method as at first. A comparison of the results shows at once the commercial value which may be placed upon the change of lubricants. This system has been extensively followed, not only in this country, but also on the Continent and in India and Japan, by one of the large oil companies, which very kindly loaned a magnificent equipment of indicators and other instruments used for the purpose, costing altogether about £500, for exhibition at Professor Charnock's lecture. This attracted a good deal of attention from the members, and an interesting discussion followed.

LAUNCHES AND TRIAL TRIPS.

MORUYA, twin-screw passenger and cargo steamer; built by Caledonian Engineering and Shipbuilding Company, Preston; dimensions, 149ft., 25ft. 6in. by 7ft. 8in.; engines, two sets compound surface condensing, 13½in. and 28in. by 20in., pressure 130 lb.; launch, last week.

CROWN, steam trawler; built by Crown Steam Fishing Company, Limited; to the order of Messrs. Moodys and Kelly; dimensions, 130ft., 22ft. 3in. by 12ft. 10in.; engines, triple-expansion, 12¾in., 22in., 36in. by 24in., pressure 180 lb.; launch, December 14th.

ALMANACS, CALENDARS, &c.

MESSRS. THOMAS ROBINSON AND SON, Limited, of Rochdale, have sent us a somewhat remarkable wall calendar, on which are depicted in colour methods of working timber from prehistoric times up to the present. The dates are indicated in clear figures on tear-off slips with mottoes. The Gloucester Railway Carriage and Wagon Company, Limited, has issued the well-known Gloucester Diary. No new features have been found necessary in the 1906 issue. A pocket diary and notebook from Messrs. Edward Wood and Co., 88, Cannon-street, London, contains new tables of safe loads for compound girders and stanchions amongst other handy reference matter. Messrs. Robert Boyle and Son are keeping to the combination pocket almanac, scale and inch rule which has proved acceptable for many years. Messrs. Clarke, Chapman and Co., Limited, of Gateshead, have sent us a self-opening pocket diary and notebook for 1906, which contains a large amount of useful information and an illustrated list of some of the firm's principal manufactures.

RAILWAY CLUB.—The annual general meeting, which was held on Thursday, 14th inst., at St. Bride's Institute, E.C., was very well attended. The principal business referred to the new headquarters and club-room at 92, Victoria-street, S.W. The chair was taken by Mr. A. E. Bradfield.

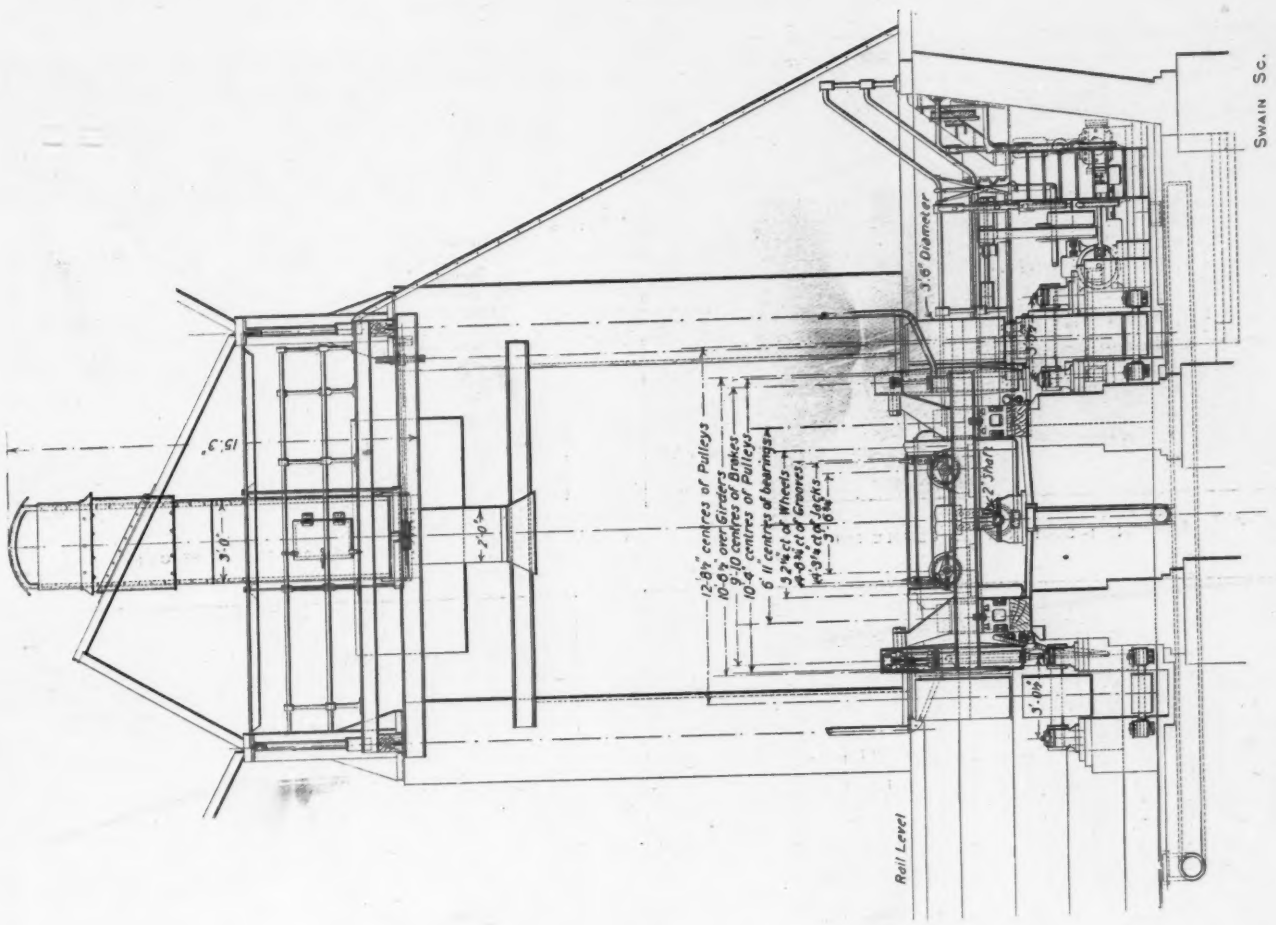
THE POST-OFFICE LONDON DIRECTORY, 1906, being the 107th edition, has made its appearance with its customary promptitude from the offices of Kelly's Directories, Limited. The value of such a publication depends upon its correctness and the "up-to-dateness" of its contents. In both these respects next year's volume is replete. We note, for instance, that the name of Mr. H. F. Compton is given as the member of Parliament for the New Forest Division of Hampshire, although his election took place as recently as December 7th last, while the change made only this month in the Government is also reflected in the Parliamentary Directory. We feel sure that the Directory will continue to meet with the appreciation of all its subscribers.

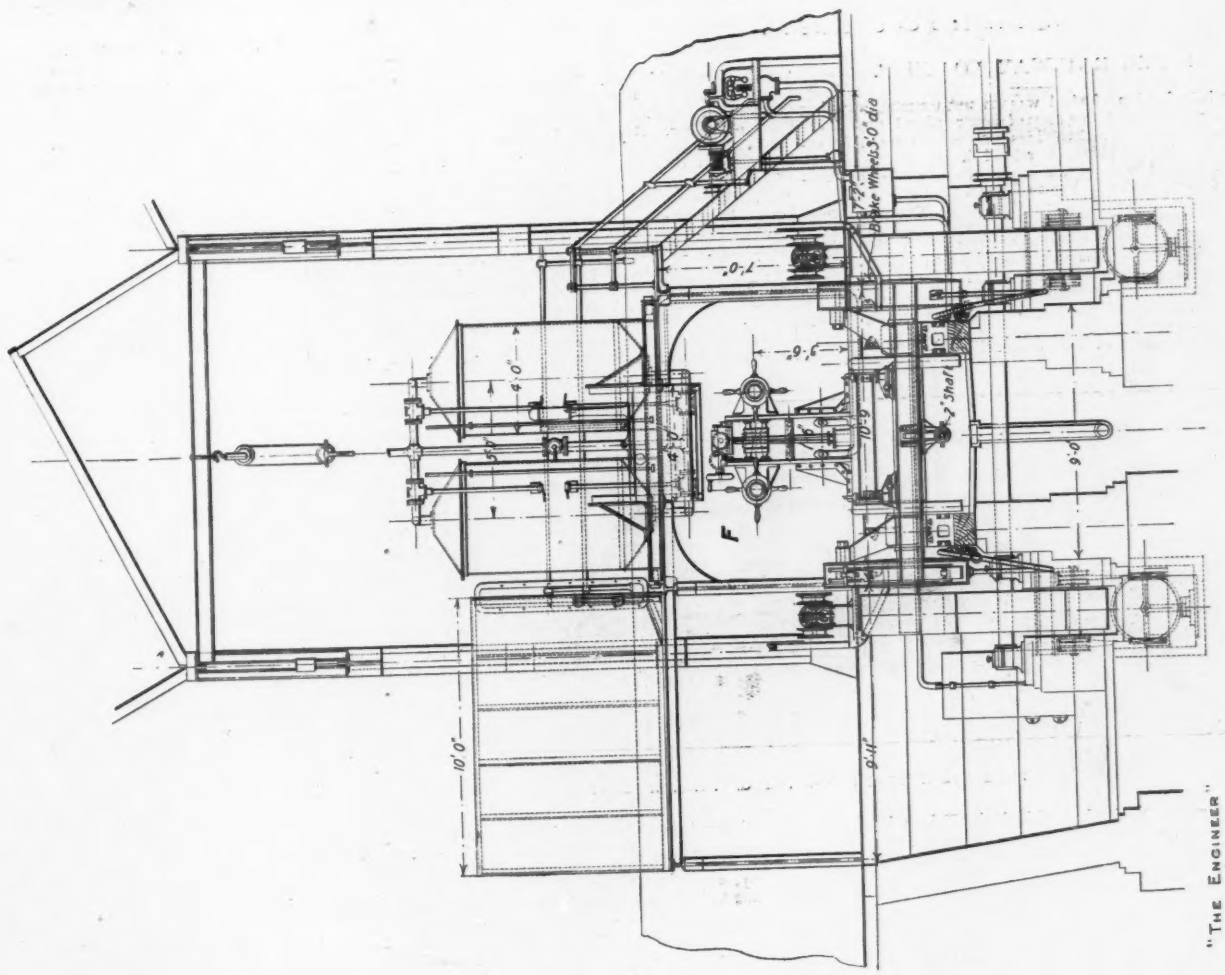
THE TOURIST TROPHY FOR MOTOR CARS.—We have received a copy of the regulations framed by the Automobile Club in connection with future competitions for the above trophy, from which we note that one or two important and commendable modifications have been made. For instance, although the weight of the chassis is to be not less than 1275 lb., no limit is imposed over and above this. The load carried will be not less than 1125 lb. The number of gears in the gear-box will be limited to four. Every competing car will be required to show that it is capable of ascending a hill of 1 in 6 on the forward gear without a flying start, and will have to be capable of being driven half a mile at 12 miles an hour on the level on the top forward gear, without the manipulation of the clutch. One gallon of petrol will be allowed for each 25 miles of roads in the Isle of Man.

LOCOMOTIVE TESTING PLANT AT SWINDON

MR. G. J. CHURCHWARD, M. INST. C.E., ENGINEER-IN-CHIEF, AND MR. C. B. COLLETT, M. INST. C.E., SWINDON, ENGINEER

(For description see page 621)





STEEL COACH FOR THE GREAT NORTHERN AND CITY RAILWAY

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED, LOUGHBOROUGH, ENGINEERS

Fig. 1—BODY NEARING COMPLETION

Fig 2—INTERIOR OF CAR

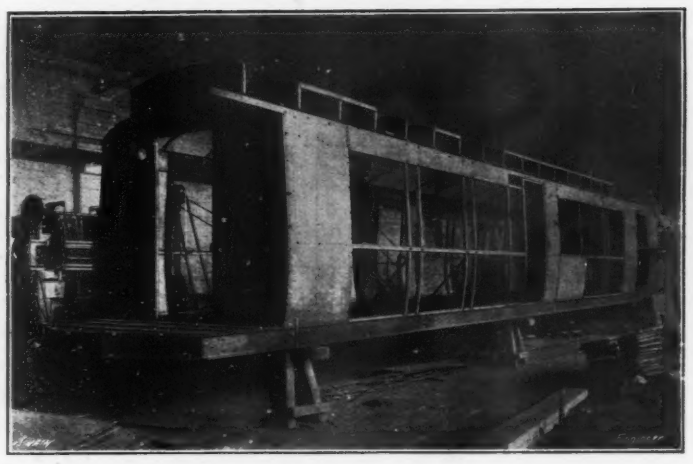


Fig. 3—PROCESS OF CONSTRUCTION

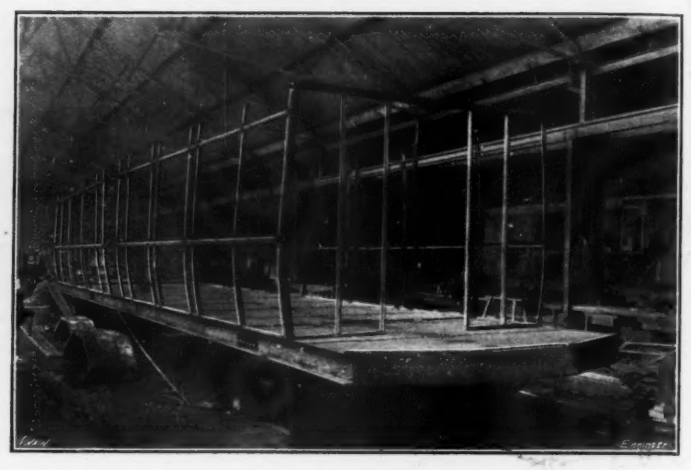


Fig. 4—STEEL FRAMEWORK

STEEL RAILWAY COACHES.

THE introduction of steel wagons upon our railways has led to the adoption of this class of construction for passenger coaches for use on suburban lines. As yet no coach for express service has been built entirely of this material, although we are informed that the Brush Electrical Engineering Company, of Loughborough, has in hand a steel dining carriage for the Great Central Railway Company. The three chief advantages claimed for this vehicle are—first, that there is reduced weight in proportion to the carrying capacity, which effects an economy in the cost of propulsion; secondly, that there is absolute safety from fire; and, lastly, that they have a much longer "life" compared with the wood coach, the steel vehicles being practically indestructible so long as they are given an occasional coat of paint.

At the invitation of the Brush Electrical Engineering Company, we on Friday last visited the Falcon Works at Loughborough, Leicestershire, where eighteen steel coaches are now under construction for the Great Northern and City Railway. They will be used in trains made up of five coaches, each accommodating sixty-four passengers, the first and the last coach being provided with motors of 120 horse-power, made by the British Thomson-Houston Company. The underframes, corner posts, intermediate pillars, car lines, and outside panels of the coaches are made entirely of steel. The floor is of sheet steel, covered with one inch layer of lito-silo, this being a non-inflammable material composed chiefly of whiting, cork dust, iron oxide, and cement. In appearance the material closely resembles linoleum, and is said to be not affected by either heat or cold. The inside panelling is of aluminium sheets $\frac{1}{16}$in. in thickness, running as high as the roof rail. The seats are of the spring type, built upon an iron frame, and covered with rattan, and the legs are made of malleable iron. The cars are well lighted, the wires for the lighting being encased in polished brass tubes attached to the car lines at the base of the clerestory roof on either side of the car. Brass parcel racks, door handles, and hand rests add to the ornamental effect.

There is nothing in the appearance of the cars, when finished, to indicate that they are made of steel, all rivets, &c., being concealed in neatly-designed mouldings. A small quantity of wood has been used, but only for ornamental purposes. The illustration—Fig. 5—shows the body of the completed car. The proper bogies, however, are not shown in the illustration. The exterior is painted the colour of teak, picked out with Indian red and gold. All the ornamental details inside the car—Fig. 2—are of teak, shown in the natural grain. The roof is painted white, and the sides cream, whilst the floor is the colour of terra-cotta.

Coming to the more technical side of the design, the cars

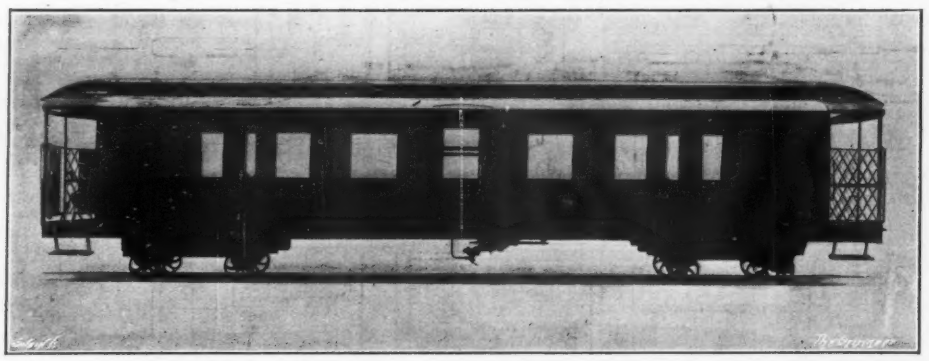


Fig. 5—STEEL COACH FOR THE G. N. & C. RAILWAY

are each constructed to carry sixty-four passengers, and are mounted on trucks of the standard Brush type, similar to those already in use upon the Great Northern and City Railway, and already illustrated in our columns. The following table gives the principal dimensions of the car:—

Length over body	41ft.
Length over platforms	49ft. 6in.
Width over pillars	9ft. 2¾in.
Extreme width	9ft. 4in.
Height from floor to roof	8ft. 5in.
Height from rail to top	12ft. 4½in.
Gauge	4ft. 8½in.
Wheel base	6ft. 1in.
Bogie centres	34ft. 6in.
Diameter of wheels	3ft.
Seating capacity	64
Weight of car body	10 tons 13 cwt. 2 qr.
Weight complete with trucks, but without electrical equipment	17 tons 11 cwt. 2 qr.

In order to keep the weight of the cars as low as possible, the full depth of the side has been utilised as a girder, thus securing great stiffness with the minimum of material. As is usual in the construction of rolling stock a high factor of safety has been adopted, no part of the frame being stressed higher than 9000 lb. per square inch. Figs. 3 and 4 show the skeleton of the framework. The underframe is braced against diagonal stresses by means of a steel floor-plate, $\frac{3}{16}$in. thick, riveted to the upper flanges of the member. This plate is strengthened by transverse flanged troughs, $\frac{3}{16}$in. high, and made from No. 1 S.W.G. sheet steel, this serving to prevent the lito-silo floor covering cracking or rising from the floor-plate. The corner and door pillars are of angle steel section, and the intermediate pillars of channel steel, shaped to the proper curvature of the side and flanged at the ends, to suit the top and bottom members of the girder to which they are riveted. In addition to the top and bottom members, which are of angle and channel steel respectively, and extend the whole length of the car, there are two intermediate members extending between the corner and side door pillars in one piece notched out to receive the intermediate pillars, and riveted thereto. These members are arranged to receive the window frames, the upper rail being of angle section, and the lower or waist rail of channel section.

The side panels are $\frac{1}{16}$in. thick, those adjacent to the corner and door pillars being in one piece from top to bottom. The panels are riveted to all the side members, the rivets being arranged in the corners to form a strong gusset. Diagonal braces of T section steel are arranged in the backs of the double seats to stiffen the sides against lateral stresses. These braces are riveted to the waist rail of the sides and to the longitudinals of the underframe. The load is transmitted to the side girders by means of longitudinals of girder section, weighing 5·4 lb. per foot run. These longitudinals are supported on cross bearers of similar but heavier section, the weight being 11 lb. per foot. The cross bearers are secured to the tension member of the side girder by angle iron knees, suitably riveted. The main bolsters are each designed to take the combined stresses due to the weight of the car and the passengers, and also the stresses set up by buffing and hauling. They are built up of two channels weighing 32 lb. per foot, with side brace plates riveted thereto, and further strengthened at the centre by steel forgings, which are utilised to take the king pin for the trucks and also for the draw-gear. The side bearings on the bolsters are pressed from $\frac{3}{16}$in. steel plate, and are fitted with $\frac{1}{16}$in. renewable wearing faces. The centre bearings are arranged so that they may be lubricated from the interior of the car. The draw-gear is of the Great Northern and City type, modified to suit the special features of the cars. The whole of the stresses are transmitted to the main bolster through a cast steel girder section bar and the king pin.

ROYAL INSTITUTION OF GREAT BRITAIN.—As already announced, a Christmas course of illustrated lectures, adapted to a juvenile auditory, on "Astronomy," will be given by Professor Herbert Hall Turner, D.Sc., F.R.S., Savilian Professor of Astronomy, University of Oxford:—Lecture 1, Thursday, December 28th, 1905; Lecture 2, Saturday, December 30th; Lecture 3, Tuesday, January 2nd, 1906; Lecture 4, Thursday, January 4th; Lecture 5, Saturday, January 6th; Lecture 6, Tuesday, January 9th. Each lecture will begin at 3 p.m.

LETTERS TO THE EDITOR.

We do not hold ourselves responsible for the opinions of our correspondents.)

THE MEANING OF ADIABATIC.

SIR,—You ask what I understand by the term "adiabatic?" I understand it exactly in the sense in which it is used by Rankine, Maxwell, Ewing, Hutton, Clerk, and Smith, quoted in your article. I see none of the want of consistency which your writer sees.

When, in the thermodynamics of a quantity of fluid, we recognise only two forms of energy—work done by it and heat received by it—the state of the stuff is completely defined by its p, v, and t. If a change of state occurs without loss or gain of heat, we say that it is an "adiabatic" change. If d H is the heat received during an infinitely small change, d H/t is called $d\,\phi$, t being absolute temperature; ϕ is called the entropy of the stuff. If d H $- p.dv$ be called d E, E is the intrinsic energy of the stuff.

The first law of thermodynamics states that E returns to its old value, and the second law of thermodynamics states that ϕ returns to its old value whenever the stuff returns to its old state. In fact, any two of p, v, t, E, and ϕ—except in the case where p and t are not independent, as in a mixture of liquid and vapour—define the state of the stuff. The word "isentropic" is sometimes used instead of "adiabatic," and I should have no objection to its use if we could make it general; but is it likely that we can make it general when Rankine and Maxwell and all other exact writers have used "adiabatic?"

It is true that I and others sometimes use the word as we use "moment" or "stress," in a wrong sense—"a matter of no moment;" "under the stress of circumstances"—but I submit that we never do use it in this way when there is any chance of our being misunderstood.

To get the most probable general law as to the state of the air at different levels in our atmosphere I say: "Take the adiabatic law." I mean: Assume that, when a portion of air changes its level, it receives or gains no heat, and receives or gains energy merely by doing work or having work done upon it by expansion or compression. I know quite well that it must, in actual fact, often gain or lose kinetic energy, gain or lose heat by friction, gain or lose electric or other forms of energy, but my assumption is that these may be neglected.

Again, in the flow of steam or air in a vessel towards an orifice, I say: "The most likely assumption to make is that the flow is adiabatic." Now, it is true that one might guard the reader or hearer from misunderstanding such a statement; but is it necessary? We mean, first, it is known that there is very little giving of heat to the stuff by friction, and there is very little radiation or conduction; secondly, the work done by the fluid in its expansion as it travels to the orifice is not given back to it again as heat, for it is still in the condition of kinetic energy, and is just as much as would have been done upon a piston in adiabatic expansion. Indeed, the use which we make of the assumption is to calculate this kinetic energy. If the stuff enters another vessel, and its kinetic energy is all converted into heat, in this part of the operation nobody would dream of saying that the flow is adiabatic, for the work done by the stuff in expanding is now given back to it as heat.

When stuff expands in a cylinder doing work upon a piston, even if the cylinder and piston are non-conducting—the expansion is not truly adiabatic, because there is commotion in the stuff, a conversion of some of the work of expansion of portions of it into kinetic energy, and a conversion of this into heat by friction. When we assume the expansion to be adiabatic we ignore these small discrepancies; we take the average p and t to be the real p and t everywhere. Horse-power is a technical term; it does not mean the power of any ordinary horse—it means 33,000 foot pounds of work done in one minute. So "adiabatic" ought not to be applied to every change in any quantity of stuff when this receives or loses no heat from or to outside things. Strictly, it is only applicable to the case in which we can speak of the stuff as being all at the same p and t at every instant. When pressure is rapidly equalised in two communicating non-conducting vessels the intrinsic energy is constant, but we cannot speak of the change as being adiabatic merely because no heat or other energy is gained or lost from the outside; during the change we cannot say that the stuff has any particular p or t, because p and t are very different in different parts of the stuff. We can, if we please, speak of the total entropy at the beginning and at the end, and at any instant we can speak of the sum of the entropies of all the infinitely small portions. Of course, this applies to what occurs at a non-conducting reducing valve. Make the statement that the intrinsic energy of a pound of wet or dry steam is the same before and after the passage, and you have a formula which enables exact calculations to be made.

There are many other things that might be said to beginners which we do not say because elaborate statements may confuse them. For example, we ought to say that we ignore molecular motions; we think of the fluid as being infinitely fine-grained or continuous. Again, when we apply the simple laws of thermodynamics arrived at by a study of fluid stresses and strains to ordinary solid bodies we ought to point out that a solid body requires many more co-ordinates than p, v and t to define its state, but that for our particular purpose this discrepancy may be ignored.

Even if the Parsons' turbine radiated no heat, the expansion cannot be adiabatic, because there is considerable fluid friction, and heat produced by friction is as if it came from an outside source. When Mr. Parsons is able to tell us more about this friction we shall be better able to say what is the nature of the expansion. In the expanding nozzle of Laval the expansion is not adiabatic, the friction is not negligible.

But even in these two cases a man of sense will learn something by first making the assumption that the expansion is adiabatic, and then trying to introduce corrections through his experiments.

I submit that everybody quoted in your article had the meaning of "adiabatic" which I have given, but that in applying his thermodynamics to any particular problem he did what is constantly being done in all applications of science—applied his simple principles and technical terms without pointing out that in any practical problem there is much greater complexity than we can easily take account of—and yet our reasoning may be of great value if its results are used with discretion.

JOHN PERRY.

December 18th.

SIR,—Your contributor, "R. M. N.," appears to me to have given a wrong title to his article. The meaning of the word "adiabatic" is definite; what he has really in his mind is the character of the lines, called 'adiabatic curves," drawn by different people. A substance, be it gas, or liquid, or solid, expands or contracts adiabatically when it does not receive heat from any external source or part with it to any external receiver. Isentropic expansion and compression have nothing to do with the definition "adiabatic." "R. M. N." has introduced a complication by bringing in the word entropy. Up to the present moment physicists have agreed to differ as to the meaning of this word, and it is therefore a mistake to pin any argument upon it.

Your contributor reads into Rankine what is not there. Take, for example, the following quotations:—"Heating and cooling of gases and vapours by compression and expansion: If a substance wholly or partially in the state of gas or vapour be enclosed in a vessel which does not conduct any appreciable amount of heat to or from the substance, then the compression and expansion of the substance, through variations of the volume of the vessel, will produce respectively heating and cooling, according to a law expressed by the condition that the thermodynamic function is constant." Your contributor says:—"This statement is, of course, wrong unless qualified. The thermodynamic function or the entropy is constant only if the algebraic sum of the heat which has leaked in or out and the heat produced by friction is zero." But Rankine is not considering the influence of heat leaked in or out, or that produced by friction. There is no qualification required. The case stated by Rankine is not the case stated by your contributor. Whether Rankine was justified in disregarding friction and leakage or not is quite another question. He may be wrong—for a real steam engine he was, of course, wrong—but his definition is right so far as it goes. Professor Ewing's definition, quoted lower down in the same column of THE ENGINEER, seems to me to be entirely perfect, and is on all fours with Rankine's.

I confess I quite fail to catch the meaning of the following, quoting Rankine again: "When the cylinder is either exposed—that is, not steam-jacketed—or simply cased in slowly conducting materials, such as wood or felt, the steam is assumed to expand without receiving or giving out heat, so that B C is an adiabatic curve." "R. M. N." writes, "According to this definition, there might be an indefinite number of adiabatics drawn through any point on a pressure volume diagram." As a bald statement, this is not true. There can be only one correct adiabatic line for any set of conditions. Take, for example, 1 lb. of air expanding down from 100 lb. to 5 lb. without receiving or parting with heat. Am I to understand that it is possible to draw any number of curves which will satisfy the conditions?

If we read your contributor's article carefully, it will be seen that if we leave out the word "entropy," he has little to say. Most of his criticisms fall to the ground. Rankine never heard of entropy, and, as I have just said, until there is general agreement as to what the word means, it is waste of time to base any argument on its introduction or its omission. In justice to himself, however, "R. M. N." ought to give us his explanation of the meaning of the word "entropy." Is it that of Swinburne, or Lodge, or Poincarré, or Perry? Of course, it cannot be that of Clausius, who, we are told, did not really understand himself what entropy is.

Westminster, December 18th. J. S. D.

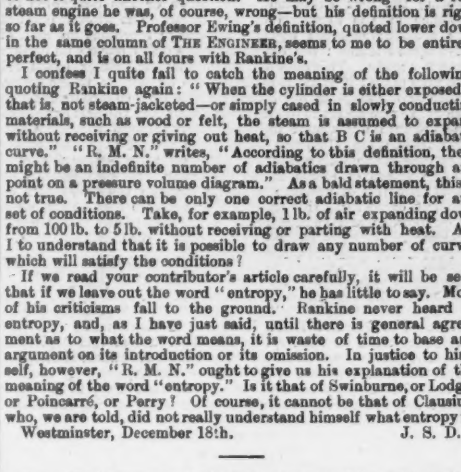
SIR,—May I occupy an inch or two to congratulate "R. M. N." on his article, which will help to clear things up. The confusion arises from my old friend entropy. Adiabatic originally meant "without heat going through," and in reversible changes that also meant isentropic. As writers discussed reversible changes almost exclusively, adiabatic and isentropic got to be looked at as the same, the result being confusion in discussing irreversible changes. I would suggest that there is no difficulty; all that is needed is to keep isentropic for changes where the entropy of the body is constant, and adiabatic for changes where no heat passes in or out as heat, whether the entropy or the internal heat increases or remains constant. There is one anomaly to be mentioned, but it causes no trouble—that is, a thermocouple with one joint inside the vessel. Though high-grade energy and no heat passes through the case, the change is virtually not adiabatic. A hot substance can thus lose entropy without any heat passing out. The change is accompanied by increase of entropy elsewhere. This anomaly need not trouble one at present; neither need radiation questions.

These points have all been raised before (I.E.E., Pres. Add., 1902; "Entropy," p. 55, &c.), but it will be very interesting to see them all discussed again—by other people. J. SWINBURNE.

December 19th.

ALLOYS RESEARCH.

SIR,—Last Friday evening, shortly after I had commenced to open the adjourned discussion at the Institution of Mechanical Engineers on the Seventh Report to the Alloys Research Committee, the Secretary quietly conveyed to me the President's ruling that I must cease to refer to the details of a paper previously read before the Iron and Steel Institute. I, of course, at once bowed to the ruling of the chair, but as the authors of the Seventh Report had therein quoted the paper in question at least eight times, my power of pointing my arguments with the facts was necessarily much crippled, and I consider that the matter thus excluded from the proceedings of the Institution of Mechanical Engineers is so vital to the points at issue that I am compelled to do that which I most dislike, namely, discuss a paper belonging to a scientific institution in the scientific Press. The facts are as follows:—I expressed my strong conviction that some iron-carbon alloys dealt with in the Report, and previously described by Dr. Carpenter and Mr. Keeling before the Iron and Steel Institute in May, 1904, had been melted in a strongly oxidising atmosphere, and were of dubious value for experimental purposes. One of the authors of the Report, in replying, stated point blank that he had definitely ascertained the atmosphere of the furnace to be reducing. The following details will prove to any steel metallurgist the strongly oxidising nature of the flame employed.



Cooling Curves of Pure Nickel

On page 58 of the Seventh Report the first metal in Table 19 is stated to contain 0·02 per cent. of carbon and a trace of manganese. This metal was originally melted from Swedish bar iron, containing about 0·05 per cent. of carbon and about 0·1 per cent. of manganese—see *Journal*, Iron and Steel Institute, 1904, No. 1, page 227.

So that the furnace at the National Physical Laboratory is capable of oxidising the carbon from 0·05 down to 0·02, and the manganese from 0·1 down to "trace" in a reducing flame. I am convinced, though I have never seen it, that the iron button in question was oxidised, riddled with blow-holes, and quite unfit for research purposes.

Turning to another subject, I must remark that the President's prohibition almost paralysed my power of driving home to the minds of members facts of vital importance connected with the erratic behaviour of the recalescence installation at the National Physical Laboratory. Therefore I now quote from Dr. Carpenter's and Mr. Keeling's paper—see *Journal*, Iron and Steel Institute, 1904, No. 1, page 237—the interdicted paragraph I wished to quote on Friday night:—

"In the case of two metal cylinders of equal size, specific heat, and emissivity, and in a uniformly-heated furnace, the cooling curve would, in the absence of critical changes, be a vertical straight line; and if these conditions were not fulfilled, the cooling curve would be a smooth curve, approximating to a straight line, but inclined to the vertical. This has been experimentally tested by taking a cooling curve, with nickel and platinum as the metals; the curve was inclined to the vertical, and no departure from a straight line was noticeable. This fact has enabled us to interpret with confidence those parts of the curve where small differences of temperature are indicated. It is interesting to note that platinum can be replaced by nickel in the differential cooling method between 1200 and 500."

I will now discuss this paragraph in conjunction with the data on Fig. 19, page 69, of the Report, first remarking that I was again handicapped during the discussion by the modesty of the authors in not including among the wall diagrams the three cooling curves of nearly pure nickel depicted in *Fig.* 19. Thoroughly sound reasons for this coyness will presently reveal themselves.

Taking the experiments of Dr. Carpenter and Mr. Keeling in 1904, one finds that in the differential recalescence installation at the National Physical Laboratory, nickel may be substituted for platinum if the temperature does not fall below 500 deg. Cent., also that blank cooling determinations on the installation register "a straight line inclined to the vertical." This, *per se*, shows at different rates a variation in the temperature of the two proportional couples which register the differential co-ordinate the points in which when joined should produce, theoretically, a vertical line. However, waiving this discrepancy, let an inclination of 10 deg. to the vertical be assumed, one then obtains with pure nickel the straight line plotted to the left in the diagram herewith, representing the Hibernian curve given by nickel at the National Physical Laboratory in 1904, say, between 800 deg. Cent. and 500 deg. Cent. But to the left of the diagram will be found the three cooling curves of pure nickel published by the National Physical Laboratory in 1905, in the Seventh Report of the Alloys Research Committee, page 69, Fig. 19.

These curves are consistent in disagreeing not only with each other, but also absolutely with the results recorded by practically the same installation in 1904, namely, "straight lines inclined to the vertical." They, in fact, present between 800 deg. Cent. and 50 deg. Cent. a remarkable variety of spinal deformities. These variations are due not to nickel, the thermal transformation of which takes place somewhat sharply about 355 deg. Cent., but chiefly to a series of changes of direction due to variation in the rate of cooling, and to variations in the temperatures of the platinum and nickel cylinders. In these circumstances the vaunted delicacy of the National Physical Laboratory apparatus renders it readily capable of registering exaggerated and prolonged thermal critical rangers which do not really exist. To sum up, the differential recalescence installation, as used at the National Physical Laboratory, is unreliable from the following causes:—(1) The rate of cooling is too slow; (2) the rate of cooling varies, causing changes of direction in the curves registered, which may be interpreted at will as critical thermal changes; (3) the temperature between the steel and platinum cylinders varies with the rate of cooling, and hence registers thermal disturbances in the steel when such are not present; (4) the cooling in air as opposed to a vacuum, as practised at the University of Sheffield, and the packing of the couples in asbestos as opposed to the Sheffield system of metallic contact, causes "lag," because the recalescence of the steel has to be radiated and conducted through a layer of magnetic oxide and the asbestos before it reaches the couple, and is conducted to the galvanometer.

I much regret to have been compelled to discuss these matters in public, but for nearly two years the authorities at the National Physical Laboratory have entirely ignored my friendly representations on the points at issue. I wish to again reiterate the fact that the conventionalities of the case compel me to criticise the authors of the Seventh Report in the plural, when, as a matter of fact, my criticism is quite singular.

May I, Sir, voice a widely spread feeling throughout the country that the young officials at the National Physical Laboratory are inclined to thrust aside the work and opinions of many British experts who had won their spurs in scientific research and discussion when these same young gentlemen were still wearing the Eton collars of the schoolboy. And, finally, may I tender to the metallurgical students of the National Physical Laboratory three items of advice which I have previously ventured to tender to research students in Sheffield, in Glasgow, and at Johannesburg:—

(1) Always ascertain and acknowledge the labours of those who have preceded you.

(2) Avoid jumping to conclusions.

(3) Invariably remember the aphorism of a famous statesman, who once said in the House of Commons, "Even very young men are not infallible."

Sheffield, December 18th. J. O. ARNOLD.

BALANCING PETROL ENGINES.

SIR,—The author of the article on the "Balancing of Multi-cylinder Petrol Engines," in your issue of the 8th inst., replies to my previous communication in a somewhat severe manner, and therefore I desire to continue the discussion by further supporting my arguments.

I am charged with "failing to grasp the significance of the question at issue." Now, may I state what I consider to be the question at issue? It is the importance of obtaining a better balance for four-cylinder petrol engines, with a suggestion by the author for a five-cylinder one. He advocates an expensive arrangement of crank shaft, with the reciprocating parts of different weights, for the four-cylinder, and and also for the five-cylinder, making the central moving parts double the weight of the others.

Whilst, of course, I was quite aware that a four-cylinder engine, as ordinarily arranged, is out of balance, I prefer to limit its use to places where it is suitable, and, where perfect balance is desirable, to use a six-cylinder one, leaving out the half-way house of a five-cylinder. I consider the author, in his article, much exaggerates the case against the ordinary arrangement of cranks in the four-cylinder. In the first place, he takes a much higher speed for the size of his motor than one would care to fit in any but a racing or special-service boat, and if he will reduce it to a normal speed of 900 revolutions, he will reduce the unbalanced force to 1400 lb. Now, if he will also lighten his moving parts to what I have found quite reasonable, he will still further reduce this force to 1100 lb. In addition to this he might use a longer connecting-rod, say five cranks long, and once more reduce it to 880 lb. I have very great doubts of long running an engine with a 6in. diameter piston, the reciprocating parts weighing as much as 30 lb. for two of the cylinders, satisfactorily at such a speed as 1200 revolutions. The total inertia pressure in this case would be, at the top of the stroke, 163 lb. per square inch of piston.

The author, in his reply, makes little of the variation of turning effort, and states the moment of inertia of the fly-wheel will only be increased as 2·6 : 2 to retain the same uniformity of revolution. This is hardly so. He gives us the coefficients of fluctuation as 1 and 1·6, which is about correct, the maximum added energy Δ E will be proportional therefore as 1 : 1·6. The moment of inertia I may be found from the formula $I = \frac{\Delta E}{\omega^2 K}$, the angular velocity ω, and the coefficient of unsteadiness K, being the same for either case, I will be proportional as 1·6 to 1.

The author stated in his article that one of the most notable features of the motor boat races at Monaco, April, 1905, was "the liability of breakdown, owing to want of rigidity in the frame of the vessel." I quite agree with this, but I certainly do not agree that it was not at all due to the rough sea at that time running. He is probably aware that up to the present nearly all the most reliable racing boats have high-speed four-cylinder engines of quite ordinary construction, but with light moving parts.

I said in my previous letter that I had never heard of the

cushioning effect of the advance spark, and I must say that I still think it has nothing whatever to do with running a motor fast. There are four reversals of motion to each cycle, and one of these only is to be cushioned, and further, this one already has the compression to perform this duty; surely the spark is advanced for quite a different reason.

The author says:—"In good practice the parts of each cylinder are made interchangeable, thus reducing first cost." Then, why does he advocate making some of his moving parts weigh 20 lb. and other sets 30 lb.?

I suppose, Sir, that your paper is solely intended for applied science, and I think that in trying to find a field for his proposed motors I was only doing what you expect your readers to do, and if the article could not be applied practically, it would not have been inserted in your valuable paper.

A. J. ROWLEDGE.

December 18th.

SIR,—The letter of "H. C. A." in your issue of December 8th is very suggestive, and certainly defines very closely the limits within which balanced engines of four or more cylinders may be used, with best results from a commercial point of view.

He states that the four-cylinder balanced engine can be thus used when the added weight of each of the two inside reciprocating masses lies between 40 per cent. and 60 per cent. of the weights of the outside masses.

It confirms the conclusion I arrived at in suggesting the design given in the article, viz., the increase in weight being 50 per cent. with the crank angles $\theta_1 = 30$ deg., $\theta_2 = 125$ deg., and the ratio $\frac{a_1}{a_2} = 2{\cdot}474$, as being the most practical and simplest arrangement.

With due deference to "H. C. A.'s" valuable criticism, there appears to be no reason why the same proportions should not do equally well for heavy oil marine engines, especially as the increase in weight of the inner reciprocating masses is quite a practical impossibility.

After giving the principal disadvantages of the proposed balanced engines, he concludes by saying that the advantages of a large four-cylinder balanced engine do not compensate the disadvantages, and it would be better to keep the speed of revolution below a certain point, so that the secondary forces with the usual arrangement of cranks become unimportant. I cannot agree with him here, for the following reasons.

As a high piston speed is absolutely necessary for an internal combustion engine on the score of efficiency, if the revolutions are to be kept at a low figure the length of the stroke must be increased accordingly. But this would bring an engine so designed under one of the disadvantages he instances for a balanced engine; for increased length of stroke involves a corresponding increase of the length of the cylinder and water jacket, and, therefore, an additional weight of metal, for which no increase in power is obtained. Further, it is open to question, whether the critical speed of revolution—which "H. C. A." does not appear to investigate—does not entail a length of stroke out of all proportion to that adopted in general practice.

He will know probably better than I do that there is a well-defined limit to the degree of compression that it is possible to use without the dangers of premature ignition, and, therefore *à priori*, a limit to the length of stroke possible, unless the clearance volume is also increased in proportion, involving the further disadvantage of additional weight.

It will at least be conceded that a speed of 200 revolutions per minute is approximately the lower limit of speed at which such an engine can be worked successfully. In a 400 brake horse-power four-cylinder marine type gas engine, described in a Supplement to THE ENGINEER some months ago, estimating the weight of the reciprocating parts of each cylinder on a somewhat low basis to be 800 lb., with a 21in. stroke and ratio of length of connecting-rod to crank 5½, at 200 revolutions per minute the unbalanced secondary force proves to be about 7000 lb., or over three tons, with a frequency—the most important factor—of 400 per minute.

Although this example is not of the heavy oil marine engine type, it serves to show the unreasonableness of "H. C. A.'s conclusion.

In conclusion, I would ask whether one of the most serious disadvantages of a high speed of revolution does not entirely disappear when the reciprocating masses of an engine are perfectly balanced? I would also thank him for the light he has thrown on the subject.

ARTHUR T. WESTON, B.Sc.
(Author of the article).

London, December 18th.

WHY ARE BOILER EXPLOSIONS VIOLENT?

SIR,—Though my letter will arrive very late in the day, I venture to offer a possible explanation of the violence of some boiler explosions, in hope that, though very imperfect in itself, it may be further developed by others who have seen the results of such explosions. I have not, and am thus somewhat handicapped, and obliged to go on what I have read, which is not quite the same thing.

My idea of the reason of the violence or shattering effect of some explosions has always been, not the impact of water driven against the plates by steam suddenly developed under the surface, but the almost instantaneous explosion of all the water in the boiler the moment the pressure is relieved, in the first case, by a rent or collapse of a plate or flue, which causes a local explosion of a small portion of the water in the boiler. Secondly, this explosion occasionally aggravates the release of pressure by providing a larger exit and corresponding greater relief of pressure, which is followed by the main explosion of a great part or the whole of the remaining water, thus blowing the boiler to pieces.

By explosion following a release of pressure I mean that if pressure in or on hot water be suddenly relieved, locally or generally, an explosion is immediately caused by the water, which is at a temperature corresponding to the initial pressure in the boiler, flying into steam in the attempt to restore the equilibrium of temperature and pressure. And that, instead of doing it slowly, as it would if the pressure were gradually reduced by, say, a stop valve, it does it instantaneously by all the water affected by the relief of pressure flying into steam at once, and thus wrecks the boiler, or part of it, by the mere shock of the explosion—that is, by the collective energy contained in the flying particles of steam, doubtless largely mixed with water. One has only to open the blow-off cock of a boiler under pressure, and notice the discharge; it is, or appears to be, mostly steam. I have no doubt that any sound boiler may be blown to pieces by the instantaneous opening of a very large stop valve, which would produce the above results.

To apply this reasoning to the St. Lazare explosion, may not the punching out of the piece of plate have been done by the first or local explosion caused by the collapse of part of the fire-box. Unfortunately, I have not by me the issue of THE ENGINEER containing the description of the accident, but if I remember rightly, the piece of plate mentioned in your article of October 6th came from the boiler barrel very near the fire-box tube-plate. There was also, I think, a patch of plate blown clean out of the outer fire-box casing right against the left-hand corner of the fire-box; this piece would fit my theory better than the piece from the barrel, as being the result of the first local explosion, and the cause of the general break up. It might be asked why a sound bit of the boiler was blown out, as the weakened fire-box was obviously the easier road. My answer would be to compare the explosion to that of a gun whose muzzle is partially choked with snow or mud, and which, when fired, bursts, though perfectly sound before; but the snow or mud goes also with the shot, *i.e.*, I assume that the recoil of the explosion comes right on the piece of plate punched out. Is it not possible that the local explosion replaces your dynamite and punched the hole which relieved the pressure in the whole boiler to such an extent as to cause the second or main explosion which blew the boiler to pieces?

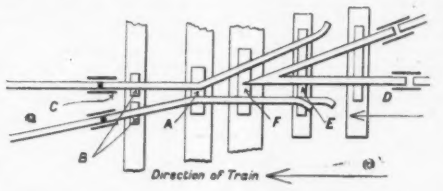
It appears to me that to produce a violent explosion the hole thus punched must be a comparatively large one, producing a very sudden drop of pressure, enabling all, or nearly all, the water in the boiler to explode, and that if the first hole or escape is small the explosion will be a quiet one, similar to the blowing down of a boiler under pressure; the extent of the collapse or failure causing the first explosion would more or less determine the violence of the explosion of the boiler. The 31 ⅞in. holes in the accident reported by Mr. Longridge represent an area of 18·6 square inches; the explosion was a quiet one, as no further rent was made. This does not prove that the local explosion did not take place; if it did it evidently did no damage to the boiler, which slowly emptied itself through the 18·6 square inches. In the St. Lazare accident the boiler did not stand the first explosion, and pressure was almost instantaneously relieved through a hole measuring some 90 square inches; the second explosion, and a very violent one, followed immediately, owing to sudden release of large volumes of steam inside the boiler, rendered possible by rapid reduction of pressure escaping through the hole blown by the first explosion. Hot water under pressure may be compared to gunpowder, and sudden relief of pressure to the match which ignites it.

GEO. W. MALCOLM.

Port Louis, Mauritius, November 13th.

THE WITHAM ACCIDENT.

SIR,—The Board of Trade Inspector, in his summing up of the evidence taken at the inquiry into the cause of this deplorable accident, places great stress on the evidence of shunter Hume, and concludes that the cause of the accident was the probable removal of some fastening at the crossing. This evidence was to the effect that a key was missing from one of the crossing or wing-rail chairs. This was strenuously denied by the permanent way witnesses, and Hume's evidence is not without suspicion in many ways. The Inspector lays no stress on the evidence of Guard Smith, who says his van lifted and dropped on the near side, *i.e.*, the side away from the crossing. It is pretty clear that the derailment took place at or very near the crossing, but it is not so clear that it was caused by any defect in the permanent way at the crossing. It is a common thing for a key to shake out under a passing train, especially in hot, dry weather. But one key being loose or out does not necessarily mean a derailment, or they would be very frequent. The keys on each side are sufficient to keep the rails steady and in place, and they were also held together at the "throat," or knuckle, by a through bolt. The opening out or loosening of the ballast on each side of the knuckle timber would not affect its bedding, and as it is a through timber, it would be held from moving laterally by the rails, chairs, and spikes right and left of the crossing. The evidence given by



driver and fireman about the men being longer than usual in clearing off the track amounts to nothing. Permanent way men are a leisurely lot, and become careless and callous, and at times run it very fine. A nervous driver, or one rendered nervous by the accident, might think or get to think the men were longer than usual; and railway men are intensely jealous each for his own department, from the highest to the lowest, and at once seize on any point which might seem to clear their department and inculpate another. To anyone who has had to do with railway maintenance and joint inquiries into accidents, this fact is well known and allowed for.

In your leading article on the accident in your issue of December 8th you say the first mark of derailment occurred "before the crossing was reached." This is, I think, a mistake, as the report says "immediately ahead of the V crossing." Ahead means beyond it, in the direction in which the train was travelling, and this is more consistent with the fact that the V crossing was found to be uninjured or unaffected in any way. I append a rough sketch of a crossing.

A is the "knuckle" chair which was found broken, with the through bolt beside it.

B, these two chairs were also broken.

C, first mark found on fish-plate.

These marks clearly show where derailment began, but the cause of this is not so clear. Possibly the knuckle chair A was broken by the sudden blow from the engine wheels striking it at such high speed, or it may have been broken some time previously. If so, it is possible that the sudden strain broke the through bolt and allowed the road to spread sufficiently under the tender to drop the leading wheel of the first vehicle behind the tender. This would account for Guard Smith's sensation of a lift and drop of the near or outer wheel; it would tend to lift as the far wheel sank, and would drop outside the left-hand rail. The first derailment could not have occurred, say, about point D, as in that case the wheel would have gone between the wing rail and V, and chairs marked E and F would have been marked or broken, or it is possible that some of the ballast cleared away from the sides of the knuckle timber, but not removed clear of the line, might have been struck by some part of the tender brake gear and knocked into the jaw of the knuckle, and resting on top of the distance piece of the chair, caused the flange of the leading wheel to jump and so be derailed.

It is possible that something—some part of the brake rigging—might have dropped on the near rail and so caused the wheel to jump and derail; or that a spring failure might have caused the apparent sudden lift and drop of the vehicle. The six springs of the leading vehicle are noted as strained, but not broken, and if the connections to the spring hangers were intact, then a dropped spring cannot have been the cause. There still remains my first theory of a break-away and slight collision that bumped the train off the line.

Whatever caused the derailment, I do not for a moment believe that a key was missing, as alleged. In the first place, there was no necessity to knock out keys to beat up a sleeper, and even if there were that would not be done till the sleeper was fully opened out. Secondly, had a key been out or loose when the men started work their first action would have been to tighten or replace it. The most probable cause of the derailment was, in my opinion, the fracture of the knuckle chair and through bolt, and slight spreading of the road at that point.

G. H. LIST.

December 19th.

THE ELECTRIFICATION OF A SUBURBAN LINE.

SIR,—I believe the British Westinghouse Company is the firm referred to in your editorial article of last week on the London, Brighton, and South Coast Company's electrification contract. Will you, therefore, kindly allow me to make an observation or two in regard to it?

You say that of the firms tendering "only one had anything but the slightest experience of single-phase traction." Granting the difficulty of giving its due attention to every interest involved in a case of this sort, does not the statement do less than justice to the pioneers of single-phase traction?

A comparison of firms skilled in single-phase traction, limited to this country alone, with continental firms can scarcely be a perfectly fair or instructive one, since as yet no such system, working under commercial conditions, has been installed here. Going outside of it, then, and comparing the experience of the continental combine known as the Allgemeine Electricitäts-Gesellschaft with the aggregate experience of the Westinghouse Companies throughout the world, an immense preponderance in mileage and horse-power will be found in favour of the latter. In America, as you know, we are easily first. On the continent of Europe we have, in several instances, beaten the Allgemeine Electricitäts-Gesellschaft on their own ground. Even in Great Britain a lowest estimate of us should take account of our demonstration track for the system at our Trafford Park Works. But the "experience" of the British Westinghouse Company, and of every one of our companies, is, in fact, neither more nor less than the aggregate experience of them altogether. And if comparisons between us and other British companies are necessary, and not invidious, what about the experience of the firm "at Rugby" who, it is stated, are to carry out this contract by arrangement with the Allgemeine Electricitäts-Gesellschaft?

However, my purpose is fulfilled in respectfully claiming for this company your courteous consideration. The contract being now closed, all of us, without exception, may unite in heartily congratulating the London, Brighton, and South Coast directors and engineers upon their wisdom in adopting and the courage they have shown in being the first in the field with a single-phase system of railway traction.

D. N. DUNLOP.

December 20th.

[We are not quite sure that Mr. Dunlop has grasped the full meaning of the sentence he quotes. He will admit with us, we think, that with the exception of his firm no other company in this country has had extended experience of single-phase electric traction. We are fully aware of the work the Westinghouse Company has done in America and of the existence of its demonstration track, and the sentence in question, as Mr. Dunlop will see if he will consider it again, makes the exception in his favour.—ED. THE E.].

ENGINEERS IN THE NAVY.

SIR,—Your recent article on the change in the Admiralty system, and the tardy adoption of common-sense methods in dealing with the engineering branch in particular, receives practical confirmation by my own case, by which, with high mathematical training, it was not possible to foresee a career which included anything superior to the watch-keeping one you indicate as now superseded. However anxious the Admiralty of the day were to act up to their minutes, there were not the posts ashore to fill to which to allot the engineering students who successfully passed the prescribed examinations. Without some radical change, which was then not forthcoming, this fact dominated the whole subject, sufficient to bring the edifice into a toppling condition, and many resignations, my own included, were recorded at this time, which had the effect of causing the authorities to inquire into the matter and make some minor improvements; but it has been left, as you say, to the late Administration thoroughly to recognise the position, and to come to the conclusion that it is useless to impart a high degree of engineering science to pupils who are merely afterwards to employ themselves at what is irksome manual labour, in a great measure affording no scope whatever for powers of any but an average order. That all this is changed now is very much to be commended, and likely to be conducive to the well-being of the service as a whole.

C.

December 19th.

TRIALS OF SUCTION GAS PLANTS.

IN our last issue we were able to announce that the Royal Agricultural Society had decided to hold trials of suction gas producers at its show at Derby next year. The official regulations have now been issued, and are as follows. The prizes, two in number, will be a gold and a silver medal.

REGULATIONS.

1. The plant to consist of gas generating plant and engine, complete, of 15 to 20 brake horse-power as a maximum.

2. Entries for these prizes, made on the Society's forms, and accompanied by specification and detail dimensioned drawings to a scale of not less than ¼in. to the foot, in plan and elevation, showing the arrangement of the plant, must be sent to the Secretary, 13, Hanover-square, W., not later than March 15th, 1906, in order that arrangements may be made for providing the necessary space.

3. A special shed will be provided by the Society for the trials of these plants, and for their subsequent exhibition during the show. The charge for space in this shed will be at the rate of 12s. 6d. per foot run, the same rate as that for machinery-in-motion shedding.

4. Competitors must provide, fix, and remove their own foundations for the engines.

5. Each engine must be fitted with a rope or web brake on the fly-wheel—particulars of which will be given later—water trough in wheel for cooling, indicator cock and gear, revolution counter and explosion counter, to be approved by the Society's consulting engineer. Water will be found by the Society.

6. One attendant must be in constant charge of each plant to give any information which the judges may require. Any attention actually given by him to the working of the plant will be noted.

7. The trials will take place during the week previous to the show, commencing on Monday, June 18th, 1906, by which date every engine must be ready to start on its official trial. Any preliminary trials required by the exhibitor must be made previous to this date. The awards will be published immediately after the conclusion of the trials.

8. Each exhibitor will declare at what brake horse-power he intends to run his engine for the full load trial, and no variation therefrom beyond 5 per cent. more or less will be allowed.

9. Full load, half load, and light or no load trials will be made with uniform selected anthracite coal provided by the Society. A subsequent full load trial will be made with coke as fuel. Each plant will be started from cold on the full load trial. The first full load trial will be commenced with the gas generators empty.

10. A given quantity of coal will be weighed out to each competitor, the time of lighting up will be noted, and so soon as sufficient gas has been generated, and the engine is running at full power, the time will be taken. This time will be recorded as the commencement of the run, so far as fuel consumption is concerned.

11. The engines will run for nine hours under constant load, after which they will be shut down for the night and will resume running on the following day. At the conclusion of the trials the fires will be drawn, and any unconsumed coal will be weighed back and credited for what it may be worth.

12. The half-load trials will be conducted on precisely the same lines as the full-load trials, with the exception that they will be of shorter duration.

13. The light or no load trial will be of two hours' duration. No coal consumption will be recorded for this trial. No working of the fan by hand will be permitted during the half load and light or no load trials.

14. On the completion of the above trials, one full load trial of nine hours' duration will be made, using coke as fuel.

15. The points to which special attention will be directed are:—

(1) Attendance necessary; (2) general design, including facility of cleaning, and space occupied; (3) regularity of working; (4) fuel consumption, water consumption; (5) price; (6) relative proportions of gas producer and engine; (7) volume swept by piston relative to brake horse-power.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE engineering trades keep well engaged, and work will be continued as long as practicable before the Christmas holidays, as there is much work to be got through, and customers are pressing for early delivery before the end of the year. This should be a cheerful season for both employers and workpeople, since orders are more numerous, and employment more regular, than for several years past. Prices remain satisfactory, and prospects for the New Year are good.

Cinder forge pig iron is quoted 55s., as against 43s. 6d. when the year opened, or an improvement of 11s. 6d.; part-mines are 60s. to 62s. 6d., against 44s. to 46s. when the year began, or an increase of 16s. All-mine ordinary are quoted 65s., or a rise of about 10s., and all-mine best is 87s. 6d. to 90s., against 75s. to 80s. when the year opened, this being an improvement of 12s. 6d. Cold blast is now 105s., against 95s. to 100s. in January, or 10s. better. Midland descriptions have gone up considerably, Northamptons being 57s. 6d. to 60s., compared with 42s. 6d. to 43s. 6d., or 16s. increase, while Derbyshires are 58s. 6d. to 60s., or about 14s. better than when the year opened.

Manufactured iron is still being produced freely. Marked bars are £8 10s., or an advance of 10s. on the year; unmarked, £7, or better by 25s.; and galvanised corrugated sheets of 24 gauge are £12 to £12 5s., which is a rise of £1 10s. Hoop iron is quoted £7 15s., or £1 2s. 6d. better, and an improvement to the same extent has taken place in gas strip, which is now quoted £7 to £7 2s. 6d., whilst rivet iron at £7 15s. has progressed by about £1.

The steel trade this week continues favourable. This department has been gradually improving since the early part of the year, and there has been a steadily growing demand, chiefly for constructional sections for use by structural engineers and also for use by the railway rolling-stock builders. Prices have considerably improved. Mild steel bars, which opened the year at £6 to £6 5s., are now £7 5s. to £7 10s., or an improvement of about 25s., girder plates have risen in price to an even greater extent, having started the year at £6 to £6 2s. 6d., and closing it at £7 10s. to £7 15s., or a rise of as much as 32s. 6d. Boiler plates, which were then £6 15s. to £7 5s., are quoted now £8 10s. to £8 15s., or an increase of 30s.; and angles, which at the earlier date were quoted £5 5s. to £5 10s., now command about 30s. more, being quoted £6 15s. to £7. The call for semi-finished steel has also been good on account of the galvanisers, but the improvement in price has not been to the same extent as other sorts, Bessemer billets, which twelve months ago were £4 7s. 6d. to £4 10s., being now £5 to £5 5s., or an advance of 15s.

Copper has been put up recently to £80 15s., and tin to £165 15s. The former has outdistanced by 15s. the highest figure recorded in the last sixteen years, the previous record having been £80 in 1889.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—With the close of the year there is a quieter feeling. The attendance on the Iron 'Change has dwindled somewhat, and business is not of the same volume as was the case a month ago. There have been few changes to note in pig iron on the week. Lincolnshire and Staffordshire have shown no change, but Derbyshire is dearer, owing to scarcity. Scotch is decidedly in buyers' favour, and hematites are perceptibly lower. Ordinary quotations are:—Lincolnshire, No. 3 foundry, 59s. 6d.; Derbyshire, 62s.; Staffordshire, 60s.; Middlesbrough, open brands, 62s.; West Coast hematite, 79s.; East Coast ditto, 79s. net. Scotch: Gartsherrie, 68s. 3d. to 68s. 6d.; Glengarnock, 65s. 6d.; Eglinton, 65s.; Dalmellington, 64s. 6d., delivered Manchester. For delivery Heysham: Gartsherrie, 66s. to 67s.; Glengarnock, 62s. 9d. to 63s.; Eglinton, 62s. 9d.; Dalmellington, 62s. 3d. For delivery Preston: Gartsherrie, 67s. 3d. to 67s. 6d.; Glengarnock, 64s.; Eglinton, 63s. 9d.; Dalmellington, 63s. 6d.

There is little or nothing new to note in forge iron.

Finished iron continues in strong request, and although bars are not officially advanced they are not to be obtained except at a premium on list rates. Bars, £7 5s.; hoops, £7 10s.; sheets, £8 10s. to £8 15s.

Steel products continue very active. Bars, £7 5s. to £7 10s.; hoops, £7 15s.; boiler plates, £8 2s. 6d. to £8 5s.; plates for tank, girder, and bridge work, £7 15s. to £8; English billets, £5 7s. 6d. to £5 15s.; foreign ditto, £5 5s.; sheets, £8 15s. to £8 17s. 6d.

Manufactured copper is dearer. Sheets, £94 to £96; seamless copper tubes, 11¾d. to 1s.; brazed, 11¼d. to 11¾d.; brass tubes, 8¾d. to 9d.; condenser, 9¾d. to 10d.; brass wire, 8¼d.; rolled brass, 8½d.; brass sheets, 9¼d. per lb.

Sheet lead unchanged at £19 10s.

The coal trade is very quiet. Coal for manufacturing purposes is steady, and there is no change in quotations. Best coal for domestic purposes, 13s. to 14s.; seconds, 12s. to 13s.; common, 9s. to 10s. Steam and forge coal, best, 8s. 3d. to 8s. 9d. Best engine fuel, 7s. 9d. to 8s. 6d.; best slack, 7s. to 7s. 6d.; medium, 6s. to 6s. 9d.; common, 5s. to 5s. 9d. at the pit. Screened, 9s. 9d. to 10s.; unscreened, 9s. 3d. to 9s. 6d., delivered Manchester Ship Canal.

Barrow.—The hematite iron trade is fairly well employed, but the business done during the week has been partly on consumptive and partly on speculative account. This is shown by the increase in stocks during the week of 4500 tons. They now total at 51,863 tons. Makers hold stocks, but they are mainly against delivery engagements, or are intended for conversion into Bessemer or Siemens steel. Orders are, however, very largely held, and the output of the thirty-seven furnaces in blast is mainly spoken for. It is anticipated that the demand for iron will next year be fuller than at present, as the consumption at present is largely confined to the wants of mild steel makers, and it is expected with the New Year a demand will arise from Bessemer steel makers. Prices are rather easier this week at 71s. 6d. net f.o.b. for mixed Bessemer numbers. Warrant iron is at 69s. 10½d. net cash sellers, buyers not quoting. A good demand prevails for ferro-manganese, spiegeleisen and charcoal iron, but a very small business is being done in forge and foundry iron.

Iron ore is in good demand. Prices are very steady at 15s. per ton net cash at mines, and best sorts find a ready market at 19s. to 19s. 6d. per ton. Spanish ores are in large importation and considerable consumption, and prices are steady at 19s. per ton.

The steel trade is unchanged. There is very little demand for steel rails, either of light or heavy section, and only a few orders are held for forward delivery. Prices of heavy sections are at £5 17s. 6d. There are plenty of orders in the market, but buyers are plentiful, though they are objecting to pay the higher prices ruling. There is a good trade in shipbuilding material, and plates have advanced to £7 10s. per ton net cash. A small business is being done in billets and tin bars, while hoops are only a moderate trade. Merchant steel is quiet, but steel foundries are busy, and chilled iron castings are in such demand as to render overtime necessary.

Shipbuilders report no new orders, but engineers are busy.

Shipping is fairly employed. The exports from the West Coast last week included 9712 tons of iron and 7880 tons of steel, a total of 17,592 tons, being 4803 increase on the corresponding week of last year. The total exports this year have reached 793,299 tons, being 74,682 tons increase on the corresponding week of last year. Freights are firm, and higher.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE house coal trade in South Yorkshire and adjoining coalfields has been exceptionally brisk this week in view of the approaching holidays. Heavy tonnages have been sent to London and the Southern and Eastern markets generally, several of the districts having been somewhat affected in their deliveries last week through the fogs. Local requirements are stated to be rather under the average at this period of the year, but there is a good business doing, and prices are well maintained. Quotations have scarcely varied, but the tendency, in spite of the remarkably open weather, is towards firmness. Silkstone, in the best qualities, fetches 12s. to 12s. 6d. per ton; secondary sorts making 10s. 6d. to 11s. per ton. Barnsley house coal, 10s. 6d. to 11s. 6d. per ton; inferior sorts remaining at 8s. 3d. to 8s. 9d. per ton at the pits.

A very good business is still being done in steam coal, the stocks at the pits being only moderate. But South Yorkshire hards are being freely sent to Hull and Grimsby, both for export and for the use of the local steam fishing fleets. For supplies for next year's shipments moderate advances are being asked. To the various railway coaling stations locomotive coal is being despatched in heavy weights. The railway contracts, which expire at the end of this month, still remain unsettled, the companies standing out against the increased price required by the South Yorkshire coal-owners.

The prices ruling under contract are not quite equal to those of last year, but business done in the open market for superior qualities make more money. Though slack and smudge for steam generating purposes are still briskly required, the output is now so large that rates are rather easier, and sales harder to make. Coking slack and smudge are actively inquired after, with every prospect of a large demand in the immediate future, through the new patent ovens now in course of erection. For good samples 4s. 6d. to 4s. 9d., at the pits, is the quotation.

Coke is now so largely produced that though the demand is good the market is scarcely able to absorb the output. Good smelting coke is obtainable at 10s. 6d. to 11s. per ton, washed samples fetching 12s.

There is less pressure in the iron market, but prices are firmly maintained. Hematites are quoted at 82s. per ton for West Coast, and 80s. per ton for East Coast, less 2½ per cent. in each case. At the corresponding period of last year the quotations were 66s. and 61s. The principal advance has been since the end of the summer quarter. Lincolnshire No. 3 foundry is quoted at 56s., and No. 4 forge at 53s. 6d. per ton. Twelve months ago the price of Lincolnshire foundry was 50s. 6d., and of Lincolnshire forge 48s. 6d. per ton. Here again the chief advance has been during the last two quarters of the year. A good demand is reported for bar iron, though price lists remain unaltered; for Bessemer steel advances were asked by merchants.

In nearly all the heavy trades brisk business is reported. Military material has been in good request, as guns, forgings, and projectiles, and satisfactory work is now proceeding in all these important departments. For marine material there has been an increased demand of late. Drums and other work for turbine steamers, castings for hydraulic machinery, shafting of all descriptions for ocean-going and other vessels, have afforded excellent employment, with every prospect of the business being maintained and extended in the immediate future. Railway material is also being more freely placed both on home and foreign account. The companies have not altogether abandoned their method of ordering from hand to mouth, but the orders are coming forward more frequently, and are improving somewhat in volume. The colonial and East Indian requirements have also been more important of late.

In the steel trade the condition of affairs is reported to be exceedingly gratifying. At the beginning of the year the outlook for steel manufacturers was regarded as justifying sanguine expectations. These have been fully realised, more especially in the latter half of the year. The call for high-speed steel is fully maintained, and a remarkably good business is done in that quality with the United States, where the Sheffield production is in great demand.

The tool trades are steadily improving in most departments. Files are in excellent request, and certain descriptions of saws are very actively called for in the home and other markets.

The work of the year practically ends on the 23rd inst. The holidays will be shorter than usual this season, although when the season is utilised for stocktaking there will be a week given in most of the departments. In several instances, however, the stoppage will only be from Saturday to Wednesday or Thursday. The collieries, it is expected, will not be re-opened until the middle of next week or a little later.

NORTH OF ENGLAND.

(From our own Correspondent.)

WHILE on all sides evidence is to be found which bears out the reports of improving trade, it must be noted that business has generally become quieter this week, but that is attributable to the influence of the forthcoming holidays, and affords no indication that a downward movement is setting in. Almost invariably at this season demand temporarily slackens, and prices ease somewhat. Export and home railway traffic returns show that trade continues to improve, as also do the sanguine reports from other iron and steel producing countries. There is, therefore, good reason to expect that competition next year among manufacturers will be much less keen than it has been at any time since 1900, and, naturally, almost every one is looking for higher ranges of prices. Acting on this opinion, consumers have already bought pretty freely for next year, and it is expected that they will order briskly after the holidays are over.

The only branch of the iron and allied trades which cannot be accounted entirely satisfactory is that of Cleveland ordinary pig iron.

It is, at first sight, not easy to recognise why the Cleveland iron producers should have gone on all the year adding on the average 40,000 tons per month to the stock in the public stores, as it is so different from the policy which they have pursued in past years. They did not, prior to fifteen months ago, care to have their iron going into Connal's, and when they produced a substantial quantity, more than the market needed, the production was reduced; in fact, twice within the last twenty years the makers have taken steps to reduce the output by 20 per cent. This year there has been put into Connal's one-sixth of all the iron produced in the North of England, and the proportion is very much larger if the comparison is made with the output of Cleveland iron only, and it is only Cleveland iron—principally No. 3—that is being lodged in the stores.

All through the year an artificial state of affairs has ruled in Cleveland pig iron owing to the unprecedented operations of the speculators, who seem to be counting upon America taking up the surplus that has accumulated in this district, and they point to the fact that there are no stocks worth mentioning in any other iron-producing country or district in the world.

The prices of Cleveland pig iron have declined this week, though not so much for the lower qualities as for No. 3, the stock of which is accumulating the most rapidly. Thus No. 3 and No. 4 foundry have dropped 9d., and the lower qualities only 3d. Buyers have been able to get No. 3 at 52s. 9d., and No. 1 at 54s. 3d.; while No. 4 foundry has fallen to 51s. 3d. Not much of the lower qualities is made, and No. 4 forge realises 51s.; mottled, 50s. 6d.; and white 50s. per ton for prompt and next month's delivery. Lincolnshire makers who have not put their prices so much are securing custom from consumers who usually have taken Cleveland pig iron.

The makers of East Coast hematite pig iron are well situated, and have no difficulty in maintaining their prices, for they are not producing more iron than the market needs; in fact, consumers could do with more than is at present being made. There is good reason to believe that the output of hematite iron in this district during the present year will have been the largest on record, and it would have been larger still if plenty of ore had been forthcoming. The imports of foreign ore have never been anything like as large as in the current year, and into the Tees alone they will reach a million and three-quarter tons. Most producers quote 70s. 6d. per ton for mixed numbers of hematite, but some lots have been sold by second hands at 70s., which has been the general price most of this quarter. No. 4 is at 65s. per ton. Rubio ore quotations vary from 20s. to 21s., and business has been transacted at 20s. 6d. c.i.f. Tees. The rates of freights are lower than they have been.

On the 20th the total stock of Cleveland pig iron held by Messrs. Connal and Co. was 693,892 tons, an increase this month of 25,250 tons. The stock consists of 635,066 tons of No. 3, 58,076 tons of No. 4 foundry, and 750 tons not deliverable as standard iron. The stock of hematite iron in the public warrant stores is 3396 tons.

The exports of pig iron from the Cleveland district, though better than they were, are still disappointing, as they have been all the year—not in any month could a good word be spoken about them. The quantity reported this month has been 62,988 tons, as compared with 56,572 tons last month; 50,556 tons in December last year; and 48,128 tons in December, 1903, all to 20th. The deliveries are likely to be poor over the next fortnight.

The holidays will interfere with the production of manufactured iron and steel, but having plenty of work producers will limit the stoppages of operations as much as possible, especially as some of them are behind with their deliveries. Demand is satisfactory in almost all branches, and the tendency of prices is upwards. Steel sheets, singles, are up to £7 17s. 6d., less 2½ per cent., and doubles are at £8 2s. 6d., less 2½ per cent. Good inquiries are received for heavy steel rails, and £6 net f.o.b. is quoted.

The engineering industry is showing considerable improvement, and this is indicated particularly by the concessions to the workmen and the fuller employment that is given. The number of unemployed in this district has been considerably reduced. The engineering firms, as reported last week, granted the men connected with the Amalgamated Society of Engineers, and also those connected with the Boilermakers' and Shipbuilders', an advance, to take effect from the first pay in March, the wages being restored to the rates which ruled at the close of last year. Within the last few days advances have been granted to the members of the Gasworkers' and General Labourers' Union, the Amalgamated Union of Labour, and the United Society of Smiths and Strikers. The men claimed 5 per cent. on piece and 2s. per week on time, but the employers would only restore the rates that were in force at the close of last year, and then not before the pay commencing March 7th next. This was agreed to.

Orders for new steamers are not now so readily obtainable, but builders can afford to wait for more, as they generally have enough contracts on their books to ensure full work for their yards over next year.

For some years a new dry dock has been wanted on the Tees, the existing dock owned by the Tees Conservancy Commissioners being unable to accommodate many of the large vessels that now trade with the district. A private company is now engaged in boring operations, with a view of ascertaining whether a proper foundation for a dry dock such as is proposed can be found.

The coal trade shows satisfactory improvement, the revival in trade leading to a larger demand for fuel, especially steam coal, and there has been a rise of 6d. to 1s. per ton, comparing the prices for next half-year with those being paid on contracts now running. The most favourable feature of the market is the revival in the coke trade. Almost all the year this branch has been unsatisfactory, and the prices of coke did not, as in the ordinary course, follow up the quotations for iron and steel; they remained stationary, while Cleveland pig iron rose 8s. per ton and hematite 17s. 6d., because there was too much coke on the market. Now this has been changed, and there is no more being produced than is wanted, with the result that prices have gone up 2s. per ton, consumers paying 17s. 6d. for medium qualities delivered at the Middlesbrough furnaces, where most of the year they have only been able to get 15s. 6d.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been an easier feeling in the iron market this week, and prices have shown a tendency to give way to some extent. The wants of local consumers seem to be pretty well met until after the turn of the year. At the same time, speculators who had formerly purchased for an advance in prices, are understood to have been selling pretty freely in order to get out with such profit as they could obtain. Rumours that were current with reference to purchases of pig iron on American account have not been confirmed, and this has naturally caused some disappointment, and tended towards an easier condition of the market.

The output of pig iron in Scotland is fully maintained, but it is not unlikely that a number of furnaces will be put on slack blast during the holiday time.

Business has been done in Cleveland warrants from 53s. to 52s. 6d. cash, and 53s. 4½d. to 52s. 10d. for delivery in one month. Cumberland hematite has been easier, business having been done down to 70s. 3d. for delivery in one month. Scotch warrants are quoted lower at 58s. per ton. There has been a very considerable business in standard foundry pig iron down to 51s. 10d. for delivery in ten days.

The demand for Scotch hematite for the steel manufacture is constant, and the price has remained at 74s. for a considerable time, but owing to the all-round easier tendency of the market values have given way, and merchants are now quoting 72s. 6d. per ton for delivery at the West of Scotland steel works.

The prices of Scotch makers' iron are fairly well maintained. Carnbroe, No. 1, is quoted at Glasgow 65s.; No. 3, 62s.; Clyde and Calder, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Gartsherrie, No. 1, 68s.; No. 3, 63s.; Summerlee and Langloan, Nos. 1, 70s.; Nos. 3, 65s.; Coltness, No. 1, 76s.; No. 3, 66s.; Glengarnock at Ardrossan, No. 1, 68s.; No. 3, 63s.; Eglinton at Ardrossan or Troon, No. 1, 62s. 6d.; No. 3, 60s.; Dalmellington at Ayr, No. 1, 65s.; No. 3, 60s.; Shotts at Leith, No. 1, 67s. 6d.; No. 3, 62s. 6d.; Carron at Grangemouth, No. 1, 70s.; No. 3, 65s. per ton.

The shipments of pig iron from Scottish ports in the past week amounted to 5835 tons, compared with 6473 in the corresponding week of last year. There was despatched to Canada 75 tons, South America 234, India 493, Australia 858, France 130, Italy 473, Germany 15, Holland 140, Spain and Portugal 3, other countries 109, the coastwise shipments being 3305 tons, compared with 4385 in the corresponding week of last year.

The arrivals of Middlesbrough pigs at Grangemouth in the past week amounted to 12,198 tons, showing an increase of 3573. The total imports since 1st January are now 474,219 tons, which is 1724 tons more than in the corresponding period of last year.

The finished iron trade is well employed, but little fresh business is being done at the moment. This occasions no surprise, owing to the near approach of the holidays.

The steel trade is very fully occupied, having work on hand that will keep the manufacturers busy for months to come.

For a considerable time past there has been serious competition between home and German and American makers of wire nails. The foreigners have been systematically underselling the home producers to an extent which could not fail to have a serious effect. It is now intimated, however, that the prices of German and American wire nails have been advanced for our market 12s. 6d. per ton. There will still be a considerable difference in favour of the foreign nails delivered at the ports, but when inland carriage is added, a considerable part of this will disappear.

The engineering trades are generally well employed, and in particular cases there is great activity. Marine engineers are especially busy, and the locomotive and motor industries have large orders in the course of execution. Makers of marine boilers are also full of work.

The shipbuilders are now making up the totals of their output for the year, and so far as the figures are available, it seems there can be no doubt that the production will come out as a record one in the trade.

There has been rather more doing in the shipping branch of the coal trade. The aggregate shipments from the Scottish ports in the past week show an increase of 22,000 tons over those of the preceding week, and are 30,000 tons better than in the corresponding week of last year. Main coal is quoted f.o.b. at Glasgow 7s. 9d.; ell, 8s. 6d. to 9s.; steam, 8s. 9d.; and splint, 9s. 6d. to 10s. per ton. Although the weather has been somewhat unsettled, it has been mild for the season, and the demand for household coal for home use has accordingly been moderate, with no material change in prices. Coal for manufacturing purposes has sold very well at firm rates.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

If the Admiralty requirements of steam coal should total 100,000 tons as expected, there would be required to meet the large needs of the foreign railways and home steamers something like a million and a-quarter tons Cardiff coal, and 115,000 tons Monmouthshire coal from January. Among principal customers whose contracts have been accepted are the P. and O.; Royal Mail; Austrian Lloyds; Danish Railways; Cie. Generale Transatlantique. Italy, as represented by the Italian Navigation; Agua Italian Syndicate; and the Italian Meridionale are well placed.

On Friday twenty-five vessels left Cardiff with a total of 81,000 tons. Though Saturday was almost a holiday at Cardiff, by reason of the great football contest between All Wales and New Zealand, and dock offices were practically closed mid-day, there were seventeen large steamers despatched with 44,250 tons of coal, and as showing the quietly improving condition of trade, on Monday twenty-five steamers were despatched, with a total of 52,260 tons. These included all variety of tonnage, from the small ones of 92, 380, and 340 tons to 7200 tons. One hundred vessels entered Barry last week. Mid-week witnessed a fair quantity of tonnage at Cardiff, Barry, and Penarth, and there is now every appearance of a more active condition of things, especially up to the holidays. Newport continues to show a good deal of animation. Tonnage is ample, and even business for January well booked. The fact of high prices being realised at Newport and Cardiff for pitwood appears to have been early noted in France, Spain, and Ireland, and now, with more favourable weather, there has been a large arrival of wood; 20s. 6d. to 21s. are the latest prices, but the tendency mid-week was downwards, wagons being short. Closing coal prices, Cardiff, were as follows:—Best steam, 12s. 6d. to 12s. 9d., some collieries are quoting 13s. for January; best seconds, 12s. to 12s. 3d.; seconds, 11s. 6d.; drys, 11s. to 11s. 9d.; best smalls, 8s. 6d. to 8s. 9d.; best ordinaries, 8s. to 8s. 3d.; seconds, 7s. 6d. to 7s. 9d.; inferiors, from 7s. Monmouthshire semi-bituminous: Best large, 11s. 9d. to 12s.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 9d. to 11s.

House coal: There has been no spurt in this variety yet. Best is quoted at 16s. to 16s. 3d.; best ordinaries, 13s. 6d. to 15s.; seconds and other sorts, 10s. 6d. to 11s. No. 3 Rhondda, 13s. 6d. to 13s. 9d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 9d. No. 2 Rhondda, 9s. 9d. to 10s.; through, 8s. 6d. to 8s. 9d.; small, 7s. 6d. to 7s. 9d. Patent fuel, 13s. 3d. to 13s. 6d. Coke exhibits a healthy character. Furnace varieties, 16s. 6d. to 17s.; foundry, 18s. 6d. to 22s.

Swansea coal trade is tolerably brisk this week in view of the holidays, and the pressure to clear by the end of the week both coal and patent fuel showed vigour. Nearly 70,000 tons of the former and 10,625 tons of the latter were despatched. France took 32,880 tons coal and 3685 tons fuel. Cardiff despatched one cargo of 3000 tons patent fuel to Bombay this week, and a fair average in addition. In steam coal Swansea maintains quotations up to 13s.; best small, 6s. to 7s. No. 3 Rhondda has improved, 13s. 6d. to 14s.; patent fuel, 11s. 6d.; best anthracite, 19s.; seconds, 16s. to 17s.; big vein, 13s. 6d. to 13s. 9d.; red vein, 9s.; cobbles, 17s.; nuts, 17s. 6d. to 19s. 6d.; peas, 10s. 6d. to 11s. Rubbly culm still low, 4s. 3d. to 4s. 6d.; duff, 3s. to 3s. 6d.

Swansea Harbour return for November is satisfactory, notwithstanding the exceptional severity of the month. Returns show an increase of 3 per cent. in imports and 14 per cent. in exports. There was an increase in iron ore of 2000 tons, a decrease in pig iron of 2000 tons, and in American steel bars 2800 tons. Exports indicated an increase in coal, coke, and patent fuel of 51,000 tons. On the other side, tin plates and galvanised iron showed a decrease of 9000 tons owing to lessened shipments to Russia, China, and Japan. Reviewing the whole trade of the port, returns were £2000 better than the preceding month.

Some little friction has been shown amongst the hauliers since the coal settlement. Fortunately the mining agent in the district concerned took prompt action, and convinced them that coal-owners had promised due investigation early in the new year, and the workmen were pacified.

A seam of excellent coal was struck this week in No. 1 Pit, Duffryn Rhondda Colliery, Afon Valley, at a depth of 50 yards.

The activity in the iron and steel trade continues, and of late sidings at Cyfarthfa have shown large gatherings of wagons laden with tin-plate bars for various destinations. Dowlais, Ebbw Vale, and Blaenavon continue busy, and the activity at Cardiff-Dowlais is soliciting the hope that the shipbuilding venture there will be attempted. In the Swansea Valley it is stated that the demand for locally manufactured steel bars is so vigorous that stocks are at a minimum. Only one cargo of steel billets from Rotterdam came last week to Newport. Pig iron, totalling 1960 tons, from Bilbao, came to Newport, and a cargo from Harrington.

On 'Change, Swansea, this week, it was the subject of complaint that with block tin daily advancing, and recent increase in pig iron, the cost per box for tin-plate was increased 2s., which quotations did not cover. It was seriously thought that a systematic combination amongst makers was urgently required, or serious losses must result. Prices of steel bars are maintained, and also in pig iron. Bessemer mixed numbers are quoted at 69s. 6d.; Middlesbrough, 52s. 6d.; Scotch, 58s.; Welsh make, 72s. 6d.; block tin, £164 17s. 6d.; lead, £17 2s. 6d.; copper, £79; silver, 30¼ per ounce; spelter, £28 15s. 6d.; Siemens steel bars, £5 2s. 6d. to £5 5s.; Bessemer, £5 to £5 2s. 6d. Iron ore, Newport and Cardiff, 18s. 6d. to 19s.

In tin-plates shipment last week was very large: 90,000 boxes; received from works, 67,325 boxes; present stocks, 193,961 boxes. Latest prices, tin-plates, as issued on 'Change, are as follows: I.C. 20 by 14, 112 sheets, 108 lb., Bessemer primes, 13s. 3d. to 13s. 6d.; wasters, 12s. 6d. to 12s. 9d.; Siemens primes, 13s. 6d. to 13s. 9d.; wasters, 12s. 6d. to 12s. 9d.; I.C. 28 by 20, 56 sheets, 108 lb., Bessemer primes, 13s. 7½d. to 13s. 10½d.; wasters, 12s. 9d. to 13s.; Siemens primes, 13s. 9d. to 14s.; wasters, 12s. 9d. to 13s.; I.C. 28 by 20, 112 sheets, 216 lb., Bessemer primes, 26s. 9d. to 27s. 3d.; wasters, 25s. 3d. to 25s. 6d.; Siemens primes, 26s. 10½d.; wasters, 25s. 3d. to 25s. 9d.; I.C. 20 by 10, 225 sheets, 156 lb., Siemens primes, 18s. 9d.; wasters, 17s. 6d. to 17s. 9d.; I.C. 18⅔ by 14, 124 sheets, 110 lb., Bessemer primes, 13s. 6d.; wasters, 12s. 6d. to 12s. 9d.; I.C. 19¼ by 14, 120 sheets, 110 lb., Bessemer primes, 13s. 6d.; wasters, 12s. 7½d. to 12s. 9d.; odd sizes, Bessemer primes, 13s. 6d. to 13s. 9d.; big sheets, 6ft. by 3ft. by 20 gauge, £10 15s. per ton f.o.b. C.A. roofing sheets, £10 per ton. Finished black plates, £10 5s. to £10 10s., all Swansea, f.o.b., cash in fourteen days, less 4 per cent.

Slight relapse in copper and tin over the quotations end of last week.

NOTES FROM GERMANY.

(From our own Correspondent.)

Business transactions in the principal departments of the iron industry over here have been satisfactory during the week now past, and the fact that prices generally are inclined to move upwards speaks well for the position of the iron market.

Ironmasters in Silesia have done a regular trade, both locally and on foreign account, all through the present quarter. Quotations for pig iron are likely to meet with an advance before long, in consequence of the high prices that are being quoted for iron ore; and as no more supplies in Russian ore come to Silesia, the prices for iron ore are sure to rise shortly. The call for semi-finished steel is strong; malleable iron bars sell freely, as also do plates. Girders are pretty well inquired for, and hoops meet with good request. Sheets are in brisk demand for local and foreign consumption, Roumania being a good market. There is a fair amount of fresh work coming in at the rail and engineering shops, light section rails meeting with specially fair request.

The majority of the ironworks in Rheinland-Westphalia are engaged to their fullest capacity, and a good many of them can boast of having orders on their books that will keep them well occupied till spring and early summer. Raw material is rather scarce, and this has, in a number of cases, prevented ironmasters from taking all the work they would otherwise have been glad to accept. The accounts given by the Steel Convention regarding business in November of present year show deliveries in semi-finished steel to have been 173,060 t., which is the same as in October, that month having, however, twenty-six working days, against twenty-four in November. Inland consumers in semi-finished steel have mostly placed their requirements till end of the second quarter. Prospects, too, regarding the further development of the semi-finished steel trade are bright, foreign business having considerably improved since last year.

German export in iron and iron articles during the ten months from January to October of present year was 26,615,990 q., against 23,063,380 q. in the same period the year before; import was 2,631,177 q., against 2,878,015 q.

Negotiations have been carried on between the German Steel Convention and the Austrian Iron Syndicate for the purpose of regulating the mutual place of sale for girders and sectional iron. An agreement which has been in force during 1905, prohibiting the sale of German girders and sectional iron to Austria, and *vice versâ*, has had to be prolonged. In some special cases only have German manufacturers been able to sell girders to Austria-Hungary, and the same was the case with Austrian girders. Some sorts of bars and wire rods have, however, at times of a brilliant trade in Germany, been exported from Austria into Germany. On the 29th of last month several representatives of the Iron Syndicate met in Vienna, and it was resolved to prolong the agreement for 1906. An agreement has been made with Swish dealers concerning the supply of rails and sleepers.

Some sorts of coal are getting scarce in Silesia, especially anthracite and the better sorts of house fuel generally. Engine coal, too, meets with vigorous demand, and the position of prices is naturally very firm. Owing to stoppages at the Russian collieries, a brisk inquiry has been coming in from that part, and Silesian coalowners can but partially supply the fuel required, although very high prices are offered by their Russian customers.

Increasing life is reported from the Rhenish-Westphalian coal market, where engine as well as house fuel sells briskly and at very firm quotations. The scarcity of wagons continues the general and just complaint.

Taking everything into consideration, there was quite a fair trade done on the Austro-Hungarian iron market during this week and the last. Crude iron remains in animated request, and some sorts of finished iron, such as plates and rails, are well inquired for, whereas there is little ordering in the girder and sectional iron department. A few days ago the State Railways' requirements in rails for 1906, amounting to about 180,000 q., was placed with the United Austrian rail works. The contracts have to be executed by April, 1906.

In coal, as well as in coke, an animated business continues to be done in Austria-Hungary, and no change in prices can be reported since previous weeks; on the whole, inquiry has increased.

Prices for Bohemian brown coal are stiff, and demand extensive.

A generally improving tendency is reported from the French iron market; fuller employment is afforded to the various shops and foundries, and the aspect all round is more favourable than last month. A sound business was done in coal, all classes of fuel meeting with very good demand.

What has been said of the French iron market applies also for the iron industry in Belgium, which has been animated and in a very strong condition all through last week. Prospects are fair, moreover, and the New Year is likely to bring further improvements. In coal and coke a healthy trade is being done.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 6th.

The demand for steel rails still continues, and contracts aggregating close on 100,000 tons have been either actually placed, or stipulations have been agreed to which involve the acceptance of that amount of business within a short time. The Boston and Maine is the buyer of 6000 tons, making 31,000 tons in all which the company recently contracted for. Extensive railroad building is arranged for in the west, and enormous orders are coming in to all the rail mills, the largest order being for a new road to be constructed from the Missouri River to the Pacific Coast as an extension of one of the largest railway systems in the north-west. The demand for structural and fabricated material for bridge building and general construction requirements continues very heavy. The Pennsylvania Railroad will shortly be in the market for an estimated requirement of 22,000 tons for new terminal construction in the vicinity of this city. Crude iron of all kinds continues to be bought, much of it for delivery during the coming summer. Bessemer, basic, No. 2 foundry, and pipe iron, which calls for No. 3 foundry, are all in excellent demand, and contracts for early delivery are being placed wherever they can be crowded in. The tone of the market is still stronger because of the press of inquiries from all quarters. The inquiry is stimulated by the increasing probabilities of an advance in prices in both crude and finished material before the close of the year. There are symptoms of a further advance growing out of probable demands from the labour organisations which in a large section of the country controls the mills. In the eastern section of the United States where non-union labour is employed a unionising effort is in contemplation. In addition to this there are prospects of a further advance in coke. There are also rumours of a general strike in the soft and hard coal regions, which may involve the labour of 300,000 miners, but nothing definite can be said as to this annoying factor at this time.

The scarcity of copper, notwithstanding the enormous production, is threatening to force an advance. Both European and domestic buyers are placing orders for delivery during the first few months of next year, and prices range from 17⅞ to 17¾. The possibility of copper reaching 20 cents has been spoken of. Exports for the past week, 1005 tons. The lead combination has advanced all grades of lead 2 dols. per ton, or 10 points per lb., to the basis of 5·35 for the de-silverised grade, and 5·45 for the corroding grade. Pig tin has also advanced under London influences, and prices on spot offerings reached 35 cents to-day, at which several moderate-sized lots sold. Receipts so far this month, 540 tons; amount afloat, 1970 tons. The spelter market is strong, and a slight advance has been made to 6·45. Quicksilver is in good demand at 40 dols. per flask. At San Francisco the latest quotation is 38 dols. for export.

NEW YORK, December 12th.

The steel industry is in a healthy condition, and for the next two weeks will probably enjoy a much desired breathing spell.

The industry is far oversold, and there is much business yet to be placed, but the railroad and other buying interests having found that the mills are practically choked with business and are holding up further orders for the present. At the same time there is a liberal sprinkling of comparatively small orders, several of them coming from the American Bridge Company. Orders and inquiries are coming from many of the larger cities for beams, angles, and shapes for local requirements. The American Bridge Company has placed orders during the past week for 21,000 tons of steel, and expects to place orders this week for about 40,000 tons. It has the work to do and wants to make sure of the material, although it will not be required until about mid-winter. The Pennsylvania Railroad has placed orders for 22,000 tons of material for its terminal station in this city, which includes a large passenger station. Another contract has been placed by builders in this city for 5000 tons of material to erect a structure twenty-eight storeys high at West Cedar and Albany-streets. A local railroad has placed orders for 4000 tons of fabricated steel to be used in the erection of bridges within 25 miles of this city. Other smaller orders for rails have been booked, and the car builders are endeavouring to place orders for plates. Sheet and bar mills are not securing much new business, as they are unable to accommodate buyers, while the pipe mills are overcrowded with offers, and they are booking business. This fact is revealed in the purchase a few days ago of large quantities of pipe iron at a slight advance over the price of a few weeks ago.

The copper situation is practically unchanged. Our exports of copper to China up to December 1st this year were 42,000 tons. The total Chinese purchase of copper amounts to 72,000 tons. Exports of copper from Atlantic ports up to last Friday, 4559 tons for the month. The December shipments will be about the same as November. Electrolytic has advanced to 18¾, but one lot of 5000 lb. of lake copper for immediate delivery brought 19¼.

Tin is pointing upward on account of manipulations in foreign tin centres.

The output of Connellsville coke this year will aggregate 16,000,000 tons, which is a record-breaking production. Seventy-two hour coke is demanding 4 dols. per ton for the first half of next year for foundry purposes, and 3 dols. per ton for furnace purposes. The possibilities of a strike in the anthracite coal and bituminous coal regions is attracting the serious attention of the industrial managers, and the latest signs point to the possibility of some amicable arrangements being made through moderate concessions, but it is too soon to make any predictions.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Messrs. Samuel Osborn and Co., of Clyde Steel and Iron-works, Sheffield, inform us that for family reasons their business has been registered as a private limited company, under the style of Samuel Osborn and Co., Limited.

The Private Wire and Telephone Installation Company, Limited, informs us that it has removed to new and more commodious offices at 78, Queen-street, Cheapside, E.C., on Wednesday, the 20th inst. Its new telephone number will be 1243 London-wall.

Mr. Geo. F. Wheeler has given up a position in the engineer's office of Cammell, Laird and Co., Limited, Cyclops Works, Sheffield, and has started in business on his own account at Donnington, near Newport, Salop, where he is open to take some work privately.

Mr. W. H. Beck, of 115 and 117, Cannon-street, E.C., informs us that he has admitted as partners in his business of consulting engineer and patent agent his former manager, Mr. Stephen Edward Gunyon, Fellow of the Chartered Institute of Patent Agents, and his son, Mr. Alexander Edward Beck, A.M.I. Mech. E., consulting engineer. The business will be carried on in future under the style of W. H. Beck and Co.

In next summer's Naval Manœuvres torpedo craft will be engaged, and the British public will be provided with an illustration of the *rôle* of above-water and submarine vessels in the defence of great naval and commercial harbours, says the *Navy and Military Record*. At the same time this great fleet will have to illustrate the Admiralty's new method of protecting commerce. The scheme, which has been elaborated by the Board of Admiralty for the defence of British trade in all the world's seas in time of war, will be tested. Arrangements have already been made with all the great shipping firms, and they have promised their hearty co-operation.

Peat deposits are widely distributed throughout the world. In Ireland it is estimated that the peat area is not less than one-seventh of the whole island. The Irish deposits are remarkable for their great depth, many reaching a depth of nearly 50ft. The area occupied by peat in the United Kingdom is about six million acres, with an average depth of 12ft. Assuming that one acre will yield 3500 tons of dried peat, some idea of the vast stores of the crude material not yet touched in this country will be obtained. The German peat area is estimated to be more than 11,000 square miles, and the yield per square kilometre for a depth of 16ft. is approximately 800,000 tons of air-dried peat. The peat deposits of Scandinavia are estimated to contain a quantity whose fuel value is equal to that of 3000 million tons of coal.

Contracts.—The St. Pancras Ironwork Company, Limited, has received an order from the Underground Electric Railways Company of London, Limited, for spiral staircases to be fixed at all the stations on the following tube railways:—Baker-street and Waterloo; Great Northern, Piccadilly, and Brompton; Charing Cross, Euston, and Hampstead. There are upwards of forty stations, and each staircase is about 18ft. diameter, is mounted in a vertical shaft connecting the underground with the surface, and varies from 50ft. to 200ft. in height, according to the position of the station. The surface of the treads and landings are covered with a new and improved non-slipping material. The staircases are built entirely of steel. The design involves an entirely new principle in staircase construction.—Geipel and Lange's tender for provision of plant for the manufacture of disinfectant from salt water by electrolysis for a sum of £325 has been accepted by the Borough of Poplar.—Messrs. Manlove, Alliott and Co., Limited, of Nottingham, are now engaged in shipping to Pernambuco all the ironwork, firebricks, and other material required for the erection of a refuse destructor to the order of the Government of that State. This order was placed by a special representative of the Government, who visited this country and the Continent to examine into the best type of destructor. The installation consists of seven cells or furnaces, one of which is specially arranged to take the carcases of diseased animals. A water-tube boiler is being supplied for the utilisation of a certain amount of the heat generated, and forced blast will be supplied alternatively by means of a combined fan and engine on Manlove's principle and by steam jets.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS**, *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

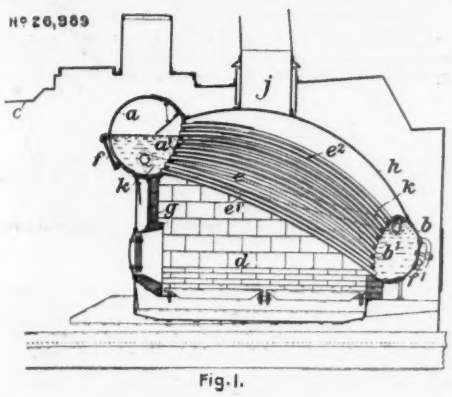
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

26,989. December 10th, 1904.—IMPROVEMENTS IN OR RELATING TO WATER-TUBE STEAM GENERATORS, Messrs. Simpson, Strickland and Co., Limited, Dartmouth, and George F. Jarvis, 7, Carlton-terrace, Dartmouth.

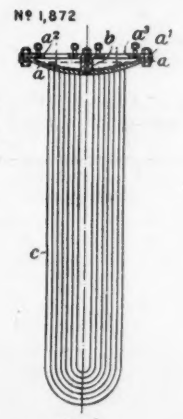
This invention relates to water-tube steam generators, and especially those for boats where the deck line comes just above the top of the generator, and has for its object so to arrange the steam and water drums and the tubes of the boiler that any one or all of the tubes can be examined, cleaned internally, and withdrawn or replaced below the deck line without disturbing the deck, this process being facilitated by the fact that access to each end of the tube can be easily obtained and work done on them without the use of special appliances. There are three figures. Fig. 1 is a sectional side elevation. The boiler comprises a steam drum *a*



and a water drum *b*, disposed transversely of the ship's deck *c*, one at each end of the furnace *d*. The steam drum *a* is disposed at a suitable height above the lever of the water drum *b*, and the generating tubes *e e e* connecting them pass across the furnace. Both the steam and water drums *a* and *b* are somewhat flattened on their facing sides a^1 and b^1, where the tubes *e* are fitted thereinto. Opposite the tube ends, and in the length of the drums *a* and *b*, are fitted one, two, or more manholes or rectangular openings *f f*, with bolted covers, covering approximately the area of the tube plates a^1 b^1 in the opposite walls of the drums *a* and *b*. The main area of the manhole or manholes or rectangular openings *f* in the steam drum *a* is formed as much under the centre of the drum as convenient, and the tubes *e* are so arranged that they may be drawn out through the manhole, and will come out at such an angle that they will always clear the deck *c* above. For instance, the lower rows of tubes e^1 may be straight or nearly so, whilst towards the top the rows e^2 may be curved. The furnace *d* will be of ordinary construction, disposed in the angular space beneath the tubes, the steam drum *a* being situated on the top of the front wall *g* of the furnace *d*. The fire will pass upward between the tubes *e*, and the latter will be covered in by a curved plate *h*, with a suitable space between it and the tubes, which space will communicate with the funnel *j*. Suitable baffle plates for directing the flow of gases between the furnace and funnel are provided. The down pipes *k* are disposed on each side of the boiler, and connect up the end of the upper steam and lower water drums.—*November 22nd*, 1905.

1872. January 31st, 1905.—STEAM SUPERHEATERS, James T. Stewart, Grove Cottage, Milton-under-Wychwood, Oxford.

This invention relates to steam superheaters for Cornish and Lancashire boilers. The circular steam chamber or chest of the superheater is composed of plates machined or pressed to the required shape and bolted together to receive the steam tubes, and is, as usually, divided into compartments to ensure proper circula-

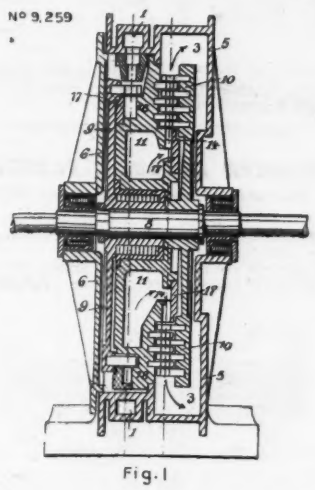


tion of the steam. There are eighteen figures. Fig. 2 is a vertical section of a simple form of circular steam superheater fitted with loop tubes. In the loop tube type of superheater the header or steam chest is constructed of a shallow dish-shaped plate *a* with a flat cover a^1 and a division bar *b*, all strongly bolted together. The loop tubes *c* have one end secured in the compartment on one side of the division bar *b* and the other end in the opposite compartment. The cover a^1 is formed with a steam inlet a^2 and a steam outlet a^3, so that boiler steam entering the steam chest is compelled to circulate through the loop tubes *c* from one compartment to the other thereof. The circular form of steam chest enables a great number of loop tubes to be located in a comparatively limited space and also to be disposed in a more favourable position to the reach of the hot flue gases. It is advantageous to place the header on a supporting plate provided with a circular flange or rim having a hole for the introduction of the superheating tubes. This plate is adapted to allow for the expansion of the header, and by reason of its rim it will be easy to cover the hole with an ordinary plate and work without the superheater when necessary.—*November 22nd*, 1905.

STEAM TURBINES.

9259. May 2nd, 1905.—IMPROVEMENTS IN TURBINES, *Otto Kolb*, 18, *Rankestrasse, Karlsruhe, Baden, Germany.*

This invention relates to turbines driven by motive fluid, such as steam, gas, or air, in which, in addition to several stages of speed of the driving fluid, several pressure stages are used simultaneously so that as low a number of revolutions as possible and efficient utilisation of the working fluid are obtained. In the arrangement shown it is presumed that the total fall of pressure is divided into two portions, and in each of these portions the fluid has four stages of speed, but the arrangements may be repeated by using, instead of two ranges of pressures, three, four and more ranges of pressure, each of which has three, four and more stages of speed, the working fluid being thereby supplied either to the same turbine wheel twice, or a great number of times, by suitable conducting passages, or—in dealing with large units—to guiding vanes and revolving wheels arranged one within the other. There are sixteen figures. Fig. 1 is a section in line with the axis of rotation of the turbines.

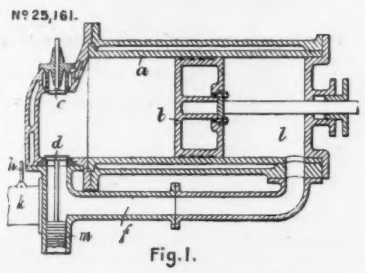


The turbine casing consists of an annular live steam passage 1 provided with inlet branch, an annular exhausting passage 3 with outlet branch, and covers 5 and 6 closing the casing on both sides. The live steam passage 1 has connected to it an expansion or inlet nozzle or several such nozzles corresponding to the first expansion stage. On a shaft 8 are mounted a set of wheels 9 and 10, off which the wheel 9 has a single series of buckets, while the other 10 has several series of buckets. A receiver 11 is included in the casing between the turbine wheels 9 and 10. The expansion nozzles 14 of turbine wheels having a number of series of buckets, are formed in the receiver. The conducting passages, constituting secondary nozzles of wheels with single series of buckets, are grouped alternately on the inner and outer peripheries of the turbine wheels, and are built in the receiver 11. The sides of the expansion nozzles and conducting passages or secondary nozzles are covered by rings, or segments of rings 17. The fixed vanes 18 for multiple stage turbine wheels are arranged on the side of the receiver 11.—*November 22nd*, 1905.

INTERNAL COMBUSTION ENGINES.

25,161. November 19th, 1904.—IMPROVEMENTS IN INTERNAL COMBUSTION ENGINES, Colonel Sir John W. Ottley, Coopers Hill, Englefield Green, Surrey, and Dr. Arthur W. Brightmore, Burford, Egham, Surrey.

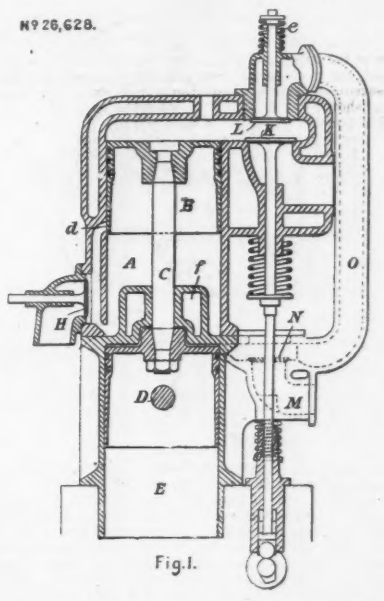
This invention has for its object to utilise the energy remaining in the working substance at the end of the explosion stroke by transferring it to the other side of both working pistons in two cylinders. This is of special importance in engines where there is a high terminal pressure after the working substance has expanded until it fills the working cylinder. There are two figures. Fig. 1 shows an irregular sectional elevation taken through one cylinder and through the main central exhaust pipe. The two working cylinders are arranged side by side, and provided with stuffing-boxes for the piston-rods to work through. The exhaust valve *d* of each cylinder *a* is connected by the piping *f* to the forward end *l* of both cylinders, so that the products of combustion, when expelled from the working or back end of either cylinder, can pass



to both the forward end of its own piston and to the forward end of the other cylinder. The engines are assumed to be working on the Otto cycle, with one piston a complete revolution in advance of the other, so that the pistons *b* are always moving in the same direction at the same time, and an explosion takes place every revolution in one of the two cylinders. A valve, not shown, is adapted to open the forward end *l* of both cylinders to atmosphere through the pipe *k* during both working strokes. Such valve is preferably closed slightly before the pistons reach the end of the working stroke, so as to raise the pressure in the pipe *f* up to that existing in the working cylinder when its release valve *d* opens. A sudden fall of pressure on the opening of the release valve is thus avoided by equalising the pressure on both sides thereof. The inlet valves *c* and the ignition devices are arranged and operated in any ordinary way, and the release valves *d* and the exhaust valve may also be adapted to be operated from the ordinary two to one shaft, a vertical pivoted lever *h* being preferably used to work the valve from its cam. In the operation of the engine the explosions take place only at the back ends of the cylinders, and after an explosion has taken place in one cylinder and the products of combustion expanded until the piston has reached its forward end, the release valve *d* in that cylinder is opened. During the return stroke these products of combustion pass into the forward ends of both cylinders, equilibrating the piston of the first-mentioned cylinder and assisting that of the other cylinder to perform its compression stroke. Slightly before the pistons reach the end of their backward stroke, and before the release valve *d* of the exhausting cylinder is closed, the valve in *k* is opened, and remains open during the forward stroke. It may, however, close slightly before the end of the forward stroke for the purpose above explained. The valves *d* may, if desired, be balanced by means of a piston valve *m*, so that it will close more readily.—*November 22nd*, 1905.

26,628. December 7th. 1904.—IMPROVEMENTS IN INTERNAL COMBUSTION MOTORS, Arthur J. Rowledge, 43, Dora-road, Small Heath, Birmingham.

Internal combustion motors at present in use following the two-stroke cycle have not been sufficiently satisfactory in practice to compete seriously with motors built on the four-stroke cycle, although they are more simple and obtain one working stroke for every revolution of the crank. There are two figures. Fig. 1 is a vertical section. Assuming that an explosive charge has been compressed within the cylinder A and ignited, the piston B is driven through its working stroke, and air which has been drawn by the previous stroke into the inner end of this cylinder through the valve H is compressed within such end of the cylinder, and a mixture of air and fuel is drawn through the passage M into the rear end of the cylinder E, the valve N being opened either mechanically or by the suction to admit thereof. As the piston B is nearing the end of its inward stroke it uncovers the port *d*, and compressed air rushes therethrough from the inner end of the cylinder A, driving out the exhaust gases from the cylinder through the exhaust valve K, which is opened for the purpose, and thoroughly scavenging out the cylinder. On the return stroke the piston B first closes the port *d*, and then the exhaust valve K is closed. Meanwhile the valve N having closed, the piston D compresses the mixture of air and fuel within the cylinder E. After the piston B has closed the port *d* it compresses the air within the

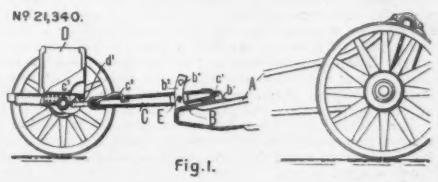


outer end of the cylinder A, and immediately, or soon after, this compression commences the inlet valve L is opened, thus allowing the charge which is being compressed within the cylinder E to flow through the passage O into the air which is being compressed within the outer end of the cylinder A, the further outstroke causing both the pistons to compress within the outer end of the cylinder A the air which has been supplied thereto through the port *d* and the mixture of air and fuel which is being supplied thereto through the passage O. The clearance between the piston D and the back end of the cylinder E, and the cubic capacity of the passage O, are made as small as is conveniently practicable to ensure that substantially the whole of the charge drawn into the cylinder E will be forced into the cylinder A at each outward stroke of the engine. When the pistons reach, or nearly so, the outer end of their stroke the inlet valve is closed, and the cycle is completed ready for the next explosion. The opening through which the piston-rod C passes is surrounded by a water jacket *f*. The inlet valve L and exhaust valve K are operated in the usual manner; but the spring *e* which tends to hold the valve L closed should be of sufficient strength to ensure that the valve will not be forced open by the pressure of the compressed air and fuel within the passage O.—*November 22nd*, 1905.

GUN-CARRIAGES.

21,340. October 20th, 1905.—IMPOVEMENTS IN OR CONNECTED WITH TRAVELLING GUN-CARRIAGES, *The Fried Krupp Aktiengesellschaft, Essen, Germany.—Date under International Convention, February 23rd*, 1905.

In order to increase the tractability of such travelling gun-carriages which are provided with a comparatively broad trail, it is customary to insert between the latter and the limber a so-called limber tree. Whereas the present ordinary arrangements of the limber tree on the gun-carriage either exclude or render



considerably difficult its use as a training lever, the arrangement of the limber tree forming the subject matter of this invention enables it to be conveniently used as a training lever. There are four figures. Fig. 1 shows a side elevation, partially in section, of a gun-carriage and limber, with the carriage limbered up, certain parts being broken away. Upon the rear end of the carriage tail A is secured a plate B, which carries a bearing block b^1 and a box-shaped frame b^2. The limber tree C is pivoted to the bearing block b^1 by means of an eye c^1, and is passed through the

frame b^2. The free end of the limber tree is fitted with two handles c^2 and an eye c^3, which latter, when the carriage is limbered up, is in engagement with the limber hook d^1 of the limber D. The limber tree C can be secured in two positions, with respect to the gun-carriage body A, by means of a key bolt E. For this purpose the frame b^2 is provided with two pairs of holes, one pair b^4 being shown, and the limber tree with a perforation. In the lower position the limber tree serves to connect the gun-carriage with the limber, while in the upper position it may be conveniently employed as a training lever.—*November 22nd*, 1905.

ROAD MOTOR VEHICLES.

22,257. October 15th, 1904.—IMPROVEMENTS IN VARIABLE-SPEED RATIO GEARING FOR DRIVING MOTOR CARS, Frank Mitchell, 8, St. Peter's-square, Hammersmith, W.

The object of this invention is to improve on the well-known friction disc type of variable-speed ratio driving gearing for motor cars in order to get its advantages without its worst disadvantages. The chief advantage is the ease with which a variation in speed ratio is obtained, while the chief disadvantage is the want of positive drive without the tendency to slip. There are five figures. Fig. 1 is a plan partly in section showing a form of the gear in which only one friction roller is required. The gear is shown as connecting the engine to the live axle, P being a cross-stay of the chassis and the axle, H and K lying longitudinally along the chassis and connecting the engine at one end to the differential gear-box of the live axle at the other end of the frame-work of the car; K is the engine shaft. The two bevel gears F^2 and F are rigidly keyed thereto. The shaft K is bored to form a journal or bearing for the end of the shaft H marked H^2. This shaft H also takes a bearing A^2 in the frame A, and is connected at the outer end to drive the road wheels. This frame has another bearing A^1 for the shaft K and carries on adjustable ball bearings, one of which is shown at C and C^2, two friction discs D and D^1, having teeth at their peripheries, which teeth mesh with those on the bevel wheel F, and are perfectly cut in vulcanised fibre or

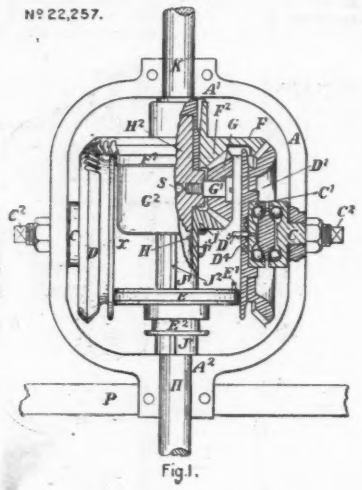


Fig.1.

similar material. One of these discs D^1 is shown in section. F^1 on the gear casing G^2 is a ridge to receive the pressure from the screws C^2 on one side of the discs when necessary, or the discs may be supported by the ball bearing in any suitable manner while the other sides of the discs press on the adjustable roller E. E has a journalled boss E^2, and is made to slide on sleeve J^1 endwise from A^2 to G^2, and is loosely keyed on a long featherway J^2 so that all its rotary movement must be imparted to the gear J. The journal E^2 is connected to a fork on the end of a lever—not shown. The parts C and C^1 in section show one of the ball bearings of the friction discs D and D^1 through which pressure is transmitted on to the roller E, a similar bearing being on D. When the friction roller E is right in its pin E^1 catches on the pin D^3; this, of course, prevents any rotation of the roller E and the plate D^4 is to allow D and D^1 to still rotate without wearing flat places on the surface of E, D having a similar plate D^4; G shows one of a set of four bevel planetary pinions mounted on the axle H in the usual manner, the pinions being in mesh with the bevel gears J and F^2, and forming an ordinary differential; S shows a hole to receive another of the pinion studs G^1; G^2 is an oil-tight casing enclosing the differential motion. The action is as follows:—K, F, F^2, D, and D^1 are driven at engine speed, D and D^1 causing the roller E to revolve in the reverse direction to that of F^2. Thus, the plane pinions G are driven at both sides. When the roller E is in the position shown the roller E—carrying gear J—would rotate backwards at the same speed as the driving members—carrying gear F^2—rotate forward, therefore the planets will revolve without moving the shaft H. If roller E is shifted outwards, then F^2, still revolving, say, 100 turns forward, E being on a larger circle of the friction discs will turn J backwards. The result will be that the shaft H will be driven by the planets 10 revolutions backwards. Variable forward drive is obtained by shifting the roller E inwards. If shifted to the position *x*, then, having 100 revolutions of F^2 forward, there will only be 50 revolutions of J backward, the result being a forward drive of axle H of 25 turns.—*November 22nd*, 1905.

ELECTRICAL APPARATUS.

2015. February 1st, 1905.—IMPROVEMENTS IN OR RELATING TO BRUSH-HOLDERS FOR ELECTRIC DYNAMOS OR MOTORS, Lawrence C. Barker, Lyndhurst, Richmond-road, Taunton, and John W. Burleigh, 29, Greenway-road, Rowbarton, Somerset.

This invention relates to improvements in brush-holders for electric dynamos or motors, the object being to provide a device for supporting a radial carbon brush or collector in a resilient manner without allowing the carbon itself to slide against its support. The brush-holder belong to the type in which a brush-holder frame or support is carried on the usual rocker, and the radial carbon brush or collector is mounted in a holder arranged to slide on the frame, and is controlled thereon by a spring. There are four figures. Fig. 1 is a side elevation partly in section, and Fig. 2 is a plan of one form of brush-holder, embodying this invention. The carbon brush A is secured to a metal holder B, which slides on a metal support C carried on the usual rocker; and the brush A, which abuts radially against the commutator, is suitably shaped at its outer end, as in the form of a dovetail or mortise A^1, and is gripped in a holder B, the jaws B^1 of which can be fixed by one or more screws B^2. The holder guide is in the form of a circular sleeve B^3 sliding on a hollow pin C^1 on the support or frame C, and, to keep the brush in correct position, there is provided between the holder and the frame a second sliding connection, cosisting of a pin C^2 engaging in a slot B^4 in the holder B. A spring D is arranged within the hollow pin C^1, fixed to the frame C at one end and provided at the other end with a screwed spindle D^1, passing through a cap B^5 on the holder sleeve, and engaging with an adjusting nut D^2. The holder B is preferably made of aluminium, but any other suitable metal may be employed.

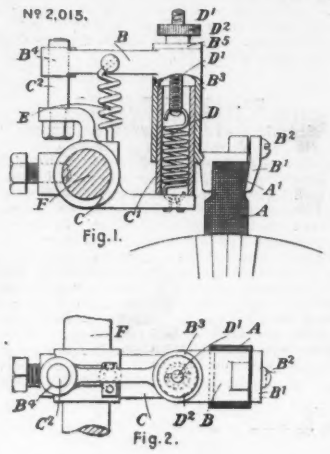


Fig.1.

Fig.2.

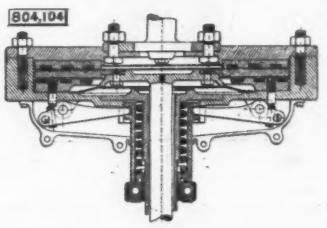
Suitable connections for leads E may be furnished on the holder, or direct from the carbon. The frame or support C is carried on a bar or spindle F in the rocker.—*November 22nd*, 1905.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

804,104. FRICTION CLUTCH, *A. de Dion and G. Bouton, Puteaux, France.—Filed April 18th*, 1905.

There is only one claim for a friction clutch having a contact surface composed of alternations of metal and lubricating material



the lubricating material consisting of blocks of graphite or graphitic carbon inserted in the surface to be brought in contact, substantially as described.

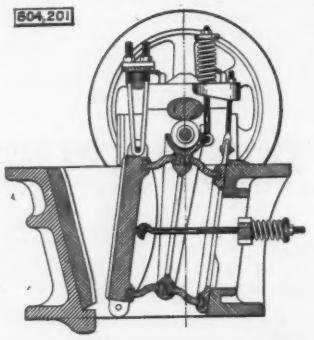
804,135. ROTARY ENGINE, *G. A. Kelly, Longview, Tex.—Filed July 31st*, 1905.

There are ten claims. The first sufficiently describes the invention. In a rotary engine, the combination with a casing having a piston chamber, of a piston rotatably mounted in the chamber and

having peripheral blades, said casing having curved channels on opposite sides of the piston chamber, said channels having their outlet mouths converging and disposed in opposing relation to project opposing and converging jets of motive fluid against the blades.

804,201. ROCK CRUSHER, *H. H. Blake, Pittsburg, Pa., assignor to Sterritt-Thomas Foundry Company, Pittsburg, Pa., a Corporation of Pennsylvania.—Filed May 19th*, 1904.

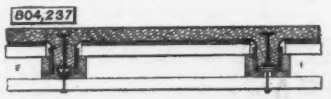
This is Mr. Blake's latest patent for machines with which his name has long been identified. There are five claims. The inven-



tion will be readily understood from the drawing. A double cam on the main shaft acts on a roller, which depresses a double set of toggles, and so actuates the crushing jaws.

804,237. CENTERING FOR CONCRETE FLOORS, *P. Kühne, New York, N.Y.—Filed March 17th*, 1905.

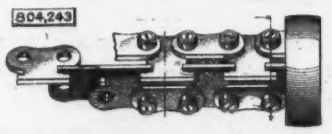
This is one of the many patents now being taken out for using



timber in the construction of concrete flooring. The details are fairly well shown in the engraving, but we give the third of the four claims to elucidate it. A screw hanger for the centering of concrete floors, comprising a U-shaped shackle, a bottom plate supported on the lower ends of said shackle, a semicircular guide plate supported at the upper part of the same, clamps applied to the hangers, bolts passing through the shanks of the clamps and the guide-piece of the shackle and washers interposed between said guide-piece and the shanks of the clamps.

804,243. RAMMER FOR GUNS, *J. F. Meigs and R. P. Stout, South Bethlehem, Pa., assignors to Bethlehem Steel Company, South Bethlehem, Pa., a Corporation of Pennsylvania.—Filed May 18th*, 1904.

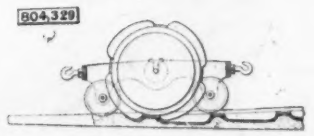
The chain rammer seems to be coming into favour again. This invention is by Lieut. Meigs, who is well known for various inventions in naval gunnery, and Mr. Stout. There are ten claims. We give the substance of Nos. 6 and 8:—A rammer having a shaft consisting in two interlocking chains, each chain comprising a series of high links and a series of low links, provided with inter-



locking horns, the high links of each chain being adapted to interlock with the high links of the other chain, and the low links of the respective chains being likewise adapted to interlock, whereby said chains are adapted to form a rigid rammer shaft. A gun is combined with a rammer frame connected with the sleeve or carriage of the gun and movable therewith. Chain guides are made in the frame, terminating in an opening in line with the axis of the gun. The chains interlock to form a rammer shaft.

804,329. CASTING PIG IRON, *E. P. Martin, Brixton, London, England, assignor of one-fourth to W. J. Eagledue, Wimbledon, England.—Filed April 22nd*, 1904.

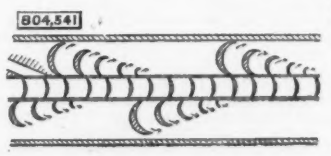
This invention is for machine-made pig beds, the mechanism consisting of parallel inclined rails, between which the sand forming the mould bed is confined, a moulding roller mounted on the



rails and adapted to be traversed over the mould bed, ribs or projections on the roller arranged with gaps between their ends and adapted to form stepped rows of horizontal pig moulds, shallow ribs in the gaps connecting the ends of the mould-forming ribs to facilitate the flow of metal from a higher to a lower mould.

804,541. TURBINE ENGINE, *H. Lentz, Berlin, Germany.—Filed April 4th*, 1905.

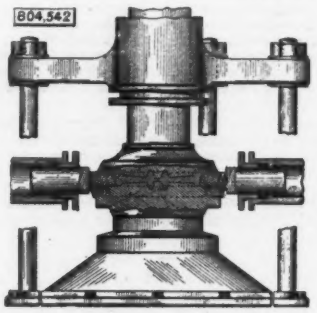
This invention is for the use of guide vanes progressively



diminishing in size, as shown in the drawing. There are five claims.

804,542. FORGING PRESS, *H. V. Loss, Philadelphia, Pa., assignor to C. T. Schoen, Moylan, Pa.—Filed December 21st*, 1904.

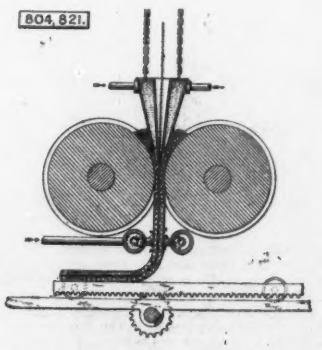
This invention is for the manufacture of railway wheels. To



the central press is added a number of radial presses, carried by a ring which can be revolved round the central vertical press. There are four claims.

804,821. MANUFACTURE OF WIRE GLASS, *A. J. Baldwin, East Orange, N.J.—Filed July 22nd*, 1904.

According to this invention, the wire is embedded in a sheet of



glass formed by two streams passing over rollers, as shown, the wire net is kept cool by two water tanks V-shaped. The glass is cooled under the rolls by a double air blast. There are five claims.

HIGH-SPEED OUTFLOW OF STEAM AND GASES.

By ROBERT H. SMITH.

No. II.*

BEYOND the narrowest section the linear velocity of flow still increases, but slowly. A very interesting and practically important point is to compare the velocity and kinetic energy acquired at this narrowest section with those that would be acquired by smooth well-guided expansion right down to zero pressure; that is, by the complete conversion of the resilient or pressure energy into the kinetic form. This ratio in respect of kinetic energy may be termed the utilisation-coefficient of the jet, if the jet be applied to its useful purpose, such as that of driving a turbine, immediately after passing this narrowest section. This important ratio takes an extremely simple algebraic and arithmetic form, namely:—

$$\text{Kinetic Utilisation} = \text{Coefficient at minimum section} = \frac{\text{Kinetic energy at ditto}}{\text{Total possible resilient work}} = \frac{i-1}{i+1}$$

This ratio is plotted as a fourth curve in Fig. 1. If the expansion were strictly adiabatic then this ratio might quite properly be called an efficiency, because all the work done would be at the expense of the resilient energy possessed by the fluid at the beginning of the flow. For a dry gas the adiabatic index is about 1·4, and $\frac{i-1}{i+1} = \frac{\cdot 4}{2\cdot 4} = \frac{1}{6}$ only. For $i = 1\frac{1}{2}$, it is $\frac{1}{5}$. For a smaller index, such as 1·1, the ratio is much smaller, as $\frac{1\cdot 1-1}{1\cdot 1+1} = \frac{1}{21}$, and as i approaches zero this ratio also decreases towards zero. This is the correct value for $i = o$, although the $(1 - \log. r)$ formula, instead of the one used above, is the proper one for the work done under this hyperbolic curve. But for isothermals, and all curves sloping less steeply than the adiabatic, the ratio is not a real efficiency, because the resilient work done under the curve is done, not in virtue solely of energy initially possessed by the fluid, but also in part in virtue of the heat energy supplied to it by conduction during expansion. In fact, the work area under the hyperbolic curve carried to indefinitely large expansion has no limit; it is immeasurably large, and this only is the reason why this utilisation ratio $\frac{i-1}{i+1}$ goes down to zero for $i = 1$.

The ratio of the velocity acquired at the narrowest section to that that would be acquired by expansion along the same curve down to absolute zero pressure is $\sqrt{\frac{i-1}{i+1}}$.

TABLE I.

Cross Sections per 1 lb. second flow divided by $\sqrt{\frac{v_1}{2gp_1}}$ at various ratios of pressure fall r.

Expansion index i	1·0	1·05	1·1	1·15	1·2	1·3	1·4	1·5
Ratio of pressure fall r ...	Section $\div \sqrt{\frac{v_1}{2gp_1}}$							
·95	4·668	4·656	4·645	4·635	4·625	4·608	4·595	4·588
9	3·422	3·414	3·405	3·397	3·389	3·372	3·355	3·326
7	2·382	2·357	2·335	2·313	2·292	2·251	2·218	2·183
6	2·320	2·288	2·254	2·221	2·190	2·135	2·090	2·050
Minimum	**2·330**	**2·286**	**2·250**	**2·216**	**2·182**	**2·120**	**2·065**	**2·017**
... ... =	*·605*	*·595*	*·585*	*·574*	*·564*	*·546*	*·528*	*·512*
5	2·396	2·340	2·290	2·245	2·203	2·120	2·068	2·017
·3	3·052	2·910	2·799	2·699	2·609	2·456	2·337	2·240
1	6·758	6·130	5·637	5·256	4·912	4·390	3·975	3·658
·05	11·65	10·37	9·39	8·60	7·90	6·81	5·98	5·35

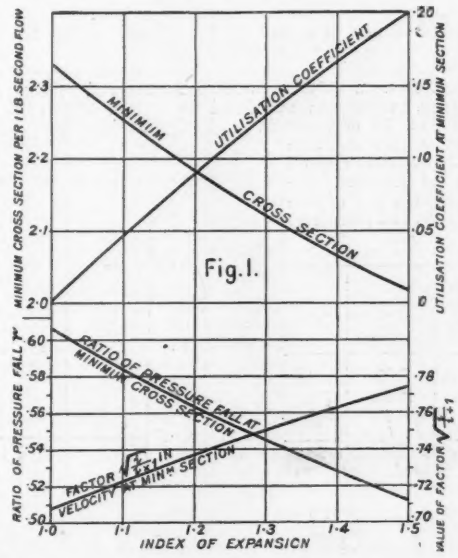
TABLE II.

Expansion index i.	Ratio of pressure fall at minimum section, $p/p_1 = r$.	Minimum cross-section per 1 lb. second flow. $A_{min}\sqrt{\frac{2gp_1}{v_1}}$	Velocity through minimum cross-section. $S_{Amin} \div \sqrt{2gp_1v_1}$.	Kinetic utilisation at minimum cross-section.
1·00	·6055	2·330	·708	0
1·05	·5952	2·290	·716	1/41
1·1	·5848	2·252	·724	1/21
1·15	·5743	2·216	·731	3/43
1·2	·5645	2·183	·738	1/11
1·3	·5458	2·120	·752	3/23
1·4	·5282	2·065	·764	1/6
1·5	·5120	2·017	·775	1/5

* No. I. appeared Dec. 22nd. Tables I. and II. and Fig. 3 repeated.

The smallness of this ratio $\frac{i-1}{i+1}$ makes it clear that no reasonable efficiency could be obtained in single-stage turbines if the jet were discharged upon the wheel immediately after passing the smallest section of the nozzle. To obtain a greater utilisation-coefficient the nozzle must be splayed outwards beyond its narrowest neck section.

But in multiple-stage turbines, or other similar impact machines, the jet may be used immediately at the neck of the channel with greater efficiency. At the first stage the fraction $\frac{i-1}{i+1}$ is converted to kinetic energy, and the fraction $1 - \frac{i-1}{i+1} = \frac{2}{i+1}$ remains unconverted. For $i = 1\frac{1}{2}$, this unconverted fraction is $\frac{4}{5}$; for $i = 1\cdot 1$, it is $\frac{20}{21}$. If, now, this kinetic energy is spent in the first stage in driving work so as to leave the discharge from the buckets with a negligible amount of kinetic energy, then we may consider the initial condition for the second stage to be one of negligible velocity; and if the same index apply to the conditions of this second expansion as to those of the first, we obtain a kinetic utilisation, referred to the original resilience at the beginning of the first stage, equal to $\frac{2}{i+1} \times \frac{i-1}{i+1}$, and a non utilised fraction $\left(\frac{2}{i+1}\right)^2$. The fraction utilised in the two stages together is thus $\left\{1 - \left(\frac{2}{i+1}\right)^2\right\}$. If there were m stages, all carried out under conditions



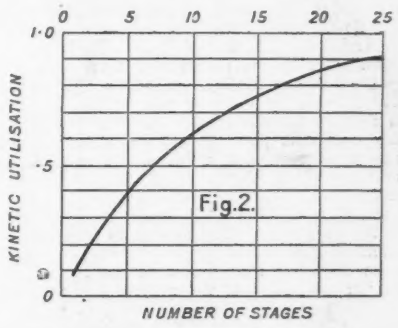
giving the same index i, and in each of which the jet was made to do its driving work immediately after passing its smallest section, and in each of which the kinetic energy was practically wholly used up, then at the end of the m stages there would be still not utilised $\left(\frac{2}{i+1}\right)^m$, and there would be a total utilisation in the m stages equal to $\left\{1 - \left(\frac{2}{i+1}\right)^m\right\}$. Of course, it is not suggested that all this last proportion of energy appears as brake horse-power in a turbine, because there is serious dynamic and frictional inefficiency in converting the kinetic energy spent in driving a turbine into useful work. We are here dealing only with the efficiency of the process of converting the resilience of an elastic fluid into kinetic energy of high-speed outflow. To illustrate this interesting law, take $i = 1\cdot 2$, when $\frac{2}{i+1} = \frac{20}{22} = \frac{10}{11}$. The following table gives the total kinetic utilisation coefficient under the conditions above named, for different numbers of stages:—

TABLE III.

Number of stages m	1	2	3	4	5	10	15	20	25	50
Total kinetic utilisation coefficient $1 - \left(\frac{2}{i+1}\right)^m$	·091	·173	·248	·317	·379	·615	·761	·851	·908	·915
Average increase of coefficient per 1 extra stage	·082	·075	·069	·062	·047	·029	·018	·011	·0003	

The results of this calculation are shown graphically in Fig. 2. Consideration of these figures in connection with the extra cost in size, weight, and workmanship involved in multiple staging yields two conclusions—(1) that in each stage the generation of kinetic energy should be carried beyond the narrow neck of the guide channels or nozzles, and (2) the advantage derivable from increasing the number of stages beyond a very moderate number—say, ten to fifteen—is comparatively small. The second conclusion (2) is, of course, reinforced in strength by the adoption of the first (1), the economic number of stages being reduced from that inferred directly from the above numerical table.

It is thus of great practical importance to determine how the sections of the guide channels or nozzles should vary both before and after the narrow neck of the channel is reached. It has been already shown that for any one set of expansion conditions the cross section varies inversely as $r^{\frac{1}{i}}\sqrt{1 - r^{\frac{i-1}{i}}}$, where r is the ratio to the initial pressure of the pressure reached at each successive cross-section. The writer has calculated this ratio for a complete range of indices i and for the complete range of pressure fall from ·95 to ·05. The resulting sections are tabulated in Table I., in which the



values for the narrowest section are specially entered in block type at the mid-depth of the table.

It will be noted from this table that for a small pressure drop like ·95 or ·90 there is little difference between the sections for very different expansion indices; but the minimum sections differ considerably, while after a long expansion down to, say, $r = \cdot 05$, the section for $i = 1$ is more than double that for $i = 1\frac{1}{2}$.

From these he has calculated, for the successive pressure ratios, the ratios of the various sections to the minimum section, taking this narrow-neck section as unit base with which to compare the sizes of all the other sections. This unit of comparison has a different absolute value per pound-second of outflow for each index i as well as for each initial condition. Its variation with i has already been shown in Table I. and by the curve in Fig. 1. In Fig. 3, which, as well as Fig. 1, have been plotted by Mr. H. M. Hodson, this correlation of A with r along the channel is shown graphically, each curve being for one index i. From $r = \cdot 95$ to beyond the minimum section the different curves fall so near each other that to the scale to which the diagram is printed it would be difficult to show them all distinctly; therefore, only the two curves for $i = 1\cdot 05$ and $i = 1\cdot 5$ have been drawn in on the left-hand side of the diagram. On the right hand all the curves are seen distinctly. The middle part of each curve, a short distance before and after the narrowest section, is re-plotted to more open scale in Fig. 4 to show more exactly the law of variation at this critical point. These section ratios are also given numerically in Table IV.

At $r = 1$, or the beginning of the expansion, the velocity is zero, and, therefore, these curves run down from an immeasurably great height at the left-hand end of the r scale. But as early as $r = \cdot 95$ they have all fallen to little more than two times the narrow-neck section. They again run to immeasurably great height near the other end of the scale $r = o$, *i.e.*, for extremely small pressure; but at $r = \cdot 05$ they have reached a height of roughly four times the narrow-neck section, or twice as much as the section at an equal distance from the beginning of the r scale. The least section is some distance to the left of the centre of the scale, but on the whole the *evasé* parts of the curves beyond the neck splay outwards from 3 to 4½ times faster than the parts before the neck is reached contract. Comparing Tables I. and IV., it is seen that from $r = \cdot 95$ to $r = \cdot 6$, the tabulated figures vary with the index i in opposite directions in the two tables.

If the successive sections have the same shape, as, for instance, circular, or elliptical with constant ratio between major and minor axes, or square, or rectangular with constant ratio between the sides, the cross linear dimension varies as the square root of the ratio shown

on the diagram. If the section be everywhere rectangular with constant width, its depth varies as the diagram ratio.

The curves show the sections between actual stream-line surfaces. But if the outside stream-line surfaces do not follow closely the solid walls of the nozzle or other channel, then the successive sections inside these walls do not determine the pressures at them. The conditions that the stream-lines may follow the outline prescribed by the walls of the nozzle or guide blades are partially explained below. If they do not follow these outlines then "dead" fluid, which does not participate in the general flow, clings to certain portions of the walls and may move slowly backwards or forwards along these walls. Such dead portions are generally in unstable equilibrium, and are liable to be caught suddenly into the general flow. Their instability causes unsteadiness in the general flow. There may also be eddies in such dead portions. It may be, sometimes, that dead portions lessen the losses by friction against the solid walls; but the other losses by viscosity and eddies introduced by them must generally overbalance the saving in wall friction, and it is probably always correct to conclude that they are altogether unfavourable to efficiency and that the outlines should be such as to avoid their formation.

If the r, scale of Fig. 3, measured axial distances along the path of the flow as well as pressure-fall, this would mean a uniform down-pressure gradient or uniform pressure drop per inch length of path. But there is nothing in the nature of the general case to determine any such uniformity of pressure gradient. Thus these curves give no clue to the axial distances apart of the sections shown by the changing height of each curve, and therefore no complete guidance in the proper designing of the shape of the nozzle or other passage.

There seem to be three considerations which ought together to determine this shape. One of these is that, in order to minimise the frictional losses in rubbing against the solid walls, the passage should be made as short as may be compatible with other desiderata. The next is that if the jet issue finally to its useful work in the form of a divergent pencil of streamlets which have necessarily all possible different directions within the limits of a cone, then the velocity in the average or axial direction alone can be utilised in useful driving work, and all the kinetic energy due to the transverse components of velocity is deprived of "effectuality." If all the streamlets within the cone be of equal velocity and of equal density, and if the cone be circular, then the sum of the energies due to these transverse components bears to the total kinetic energy the ratio $\frac{1}{3}(2 - \cos a - \cos^2 a)$, where a is the half angle of the cone. If the whole angle of the cone $2a$ were 20 deg., the transverse components would involve 1½ per cent. loss; if it were 30 deg., this would amount to a loss of 3½ per cent.; if the angle were 45 deg., the loss would be 7½ per cent.; and if the cone angle be 60 deg., there would be 13 per cent. loss. Thus while a moderate angle of 10 deg. to 20 deg. may not be considered to involve serious loss, one of 30 deg. should certainly be avoided. To diminish this angle, the only available method is to lengthen the discharge end of the nozzle, and thus these two first considerations affect the design in opposite directions. It is, however, worth observing that the object of guiding the jet into approximate parallelism at its final issue may be effected in the last short portion near the mouth, and that this second consideration need not be given influence on the shape of any other part of the nozzle except its mouth.

The third consideration has equal, if not greater, importance, and is much more difficult. It is that of avoiding eddies, "dead-water" regions, and spraying, by giving the channel "fair lines." The jet will follow the solid guiding surfaces if the laws of Nature permit it to do so; but if the lines furnished for its guidance be physically impossible ones, it cannot follow them. To give it "fair lines," it is not sufficient merely to avoid attempting to force it into *sudden changes of direction*, such as correspond to sharp corners and sharp edges. Besides this, it is necessary to avoid everywhere any *sudden change of curvature*. Thus, the guide surface or wall must not be laid out in a series of circular arcs running tangentially into each other but involving sudden change of radius at each junction; nor must a straight parallel or conical portion be joined on to a circular arc without any "transition curve." If such sudden change of curvature occur, eddies or "dead-water" must inevitably arise for a reason easily and simply explained. Where there is curvature in a fluid stream there is a transverse or cross-axial pressure gradient proportional to the curvature and to the square of the velocity. This cross-pressure gradient is due to centrifugal force, which per unit mass of the fluid equals S^2/ρ. Now, if there were sudden change of curvature, there would be sudden change of cross-axial pressure gradient, and this could not exist without finite differences of pressure occurring side by side at points in the fluid immeasurably close together. This is physically impossible in any fluid, and therefore fluids refuse to follow any paths of discontinuous curvature. There exists a further law which limits the rapidity of the permissible rate of change of curvature in proportion to the viscosity of the fluid, and in proportion to some function of the velocity; but this law has not yet been accurately determined, so far as is known to the writer of this article.

This cross-axial pressure gradient means that the different streamlets arrive at each section at different pressures, and therefore at different velocities, so that there is also a cross-axial velocity gradient. These different streamlets drag on each other by viscous interaction. The viscosity lessens the cross velocity gradient below what it would be in a "perfectly limpid" fluid; but it also involves waste of energy in work upon the viscous resistances.

The practical designer will instinctively make his change of curvature less rapid the more viscous and the more dense is the fluid and the higher the velocity—because of the cross-gradient of pressure being proportional to $d\,S^2/\rho$ with density d. Cassel and Co. manufacture a set of curve-templates designed by the present writer which give a continuous and uniform rate of change of curvature, and these are eminently well suited

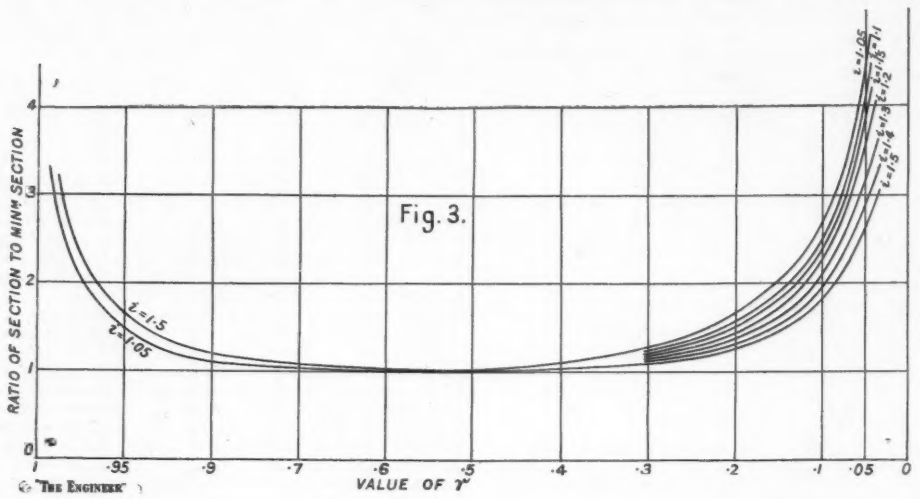


Fig. 3.

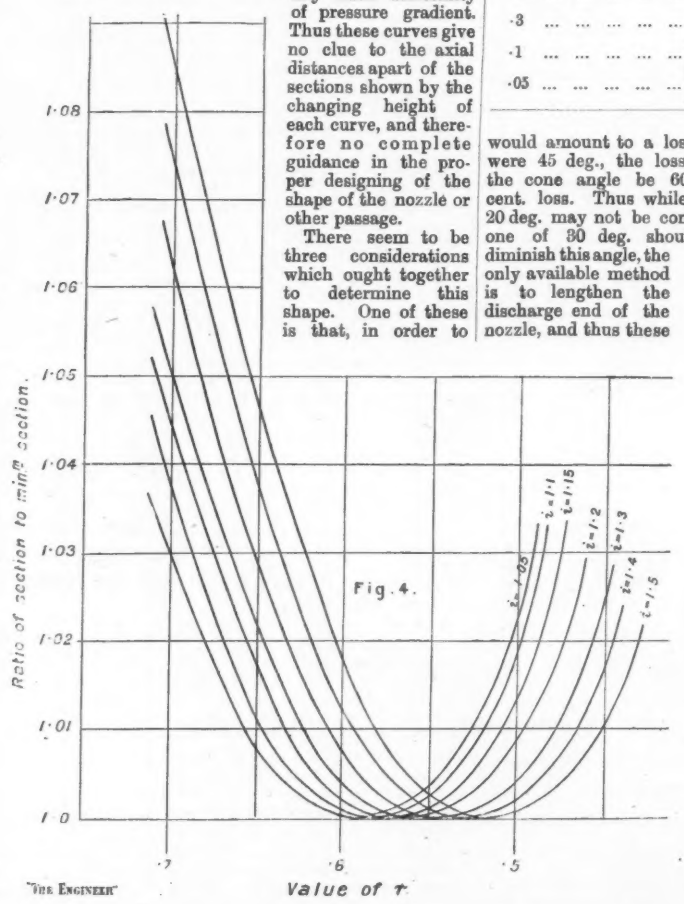


Fig. 4.

TABLE IV.
Ratio of Section at pressure fall r to Minimum Section.

Expansion index i	1·0	1·05	1·1	1·15	1·2	1·3	1·4	1·5
Ratio of pressure fall r ...	Section – ratio.							
·95	2·005	2·035	2·064	2·093	2·119	2·173	2·226	2·275
·9	1·468	1·490	1·513	1·532	1·553	1·590	1·626	1·654
·7	1·022	1·030	1·037	1·044	1·050	1·062	1·073	1·083
·6	1·000	1·000	1·001	1·002	1·0035	1·0073	1·0117	1·017
Minimum	1	1	1	1	1	1	1	1
r ... ... =	·615	·595	·585	·574	·564	·546	·528	·512
·5	1·029	1·023	1·018	1·013	1·009	1·004	1·0015	1·000
·3	1·310	1·271	1·243	1·218	1·197	1·161	1·133	1·111
·1	2·900	2·680	2·502	2·372	2·250	2·074	1·925	1·814
·05	5·000	4·532	4·172	3·870	3·620	3·212	2·900	2·651

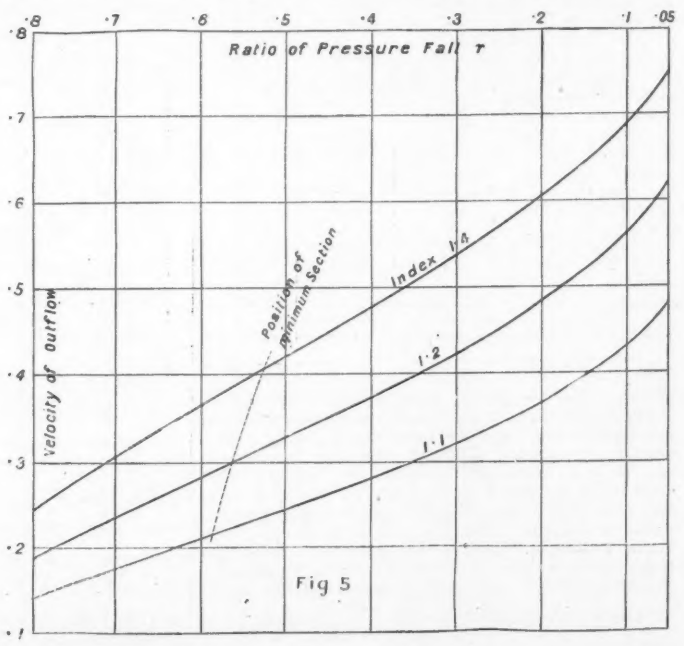


Fig 5

for drawing the fair lines of all guide channels for the flow of fluids of every kind, gas, vapour and liquid. Any patching up of a pseudo-smooth curve by joining circular arcs cannot give the true fair lines necessary to avoid waste of energy and work in fluid streams.

Following such continuous-curvature outlines the expansion may be followed to the section giving the desired pressure fall and velocity. In the last part of the channel the outline of the mouth may be given reversed curvature so as to draw the divergent jet into parallelism. This will involve further enlargement of section and further drop of pressure, so that the reversal of curvature is to begin before the desired final pressure and velocity is reached. At the anti-clinal point dividing convex from concave outline the curvature on each side of this point should be run down to zero, that is, a short—it may be a minute—straight conical length intervenes between the two.

Although the formula for the velocity of the flow in terms of the pressure has often been repeated since Rankine's time, the practical results for various indices have not been published so far as the writer is aware. The subjoined Table V. is therefore given, showing how the velocity increases with the pressure fall from $r = \cdot 8$ down to $\cdot 05$ and for three expansion indices $1 \cdot 1$, $1 \cdot 2$, and $1 \cdot 4$. The same results are plotted as three curves in Fig. 5, on which are also marked the positions of minimum section. These curves have double curvature, being concave up to the minimum section and convex beyond it. Between $r = \cdot 7$ and $r = \cdot 3$ they are thus nearly straight lines. For dry saturated steam throughout the range from 50 to 300 lb. per square inch pressure the factor $\sqrt{2\,g\,p_1\,v_1}$ varies only from 1966 to 2070 feet per second.

TABLE V.

Ratio of Velocity at Pressure fall r to $\sqrt{2\,g\,p_1\,v_1\,\frac{i}{i-1}}$ or $\sqrt{1 - r^{\frac{i-1}{i}}}$

Expansion index i	1·1	1·2	1·4
Ratio of pressure fall r ...	$\sqrt{1 - r^{\frac{i-1}{i}}}$		
·8	·142	·191	·2486
·7	·1786	·240	·311
·6	·213	·2856	·3685
·5	·247	·330	·424
·4	·283	·376	·480
·3	·322	·426	·5391
·2	·369	·485	·607
·1	·4345	·5645	·694
·05	·468	·627	·758

LOCOMOTIVE WORKS AND SHOP PRACTICE IN ITALY.

No. II.*

WE continue from December 15th our description of the Elvetica Locomotive Works of Breda, at Milan:—

Lathe shops.—In these shops Gisholt lathes are much employed for pistons, cylinder covers, and, in fact, for all work of which there is a sufficient repetition to make their use economical. Each of these machines has a complete set of spare parts and cutting tools kept in cupboards close at hand. The largest size bores holes up to 3½in. diameter. Pistons are mostly of forged cast steel, and after rough turning are finished off exactly to template by a profiling scraper. A number of American turret lathes of various sizes, by the Jones and Lamson Machine Company and other United States firms, and termed "revolvers" on the Continent, are employed here, as well also as the Pond Machine Tool Company's latest pattern lathes with 24in. to 28in. centres. A light single-track walking crane, entirely hand worked, handles the pieces from machine to machine in this shop, wherein the machines are so disposed as to reduce transport handling to a minimum.

In the drilling machine bay two central-spindle, eight-hole drilling machines, by the Bausch and Harris Machine Company, are employed, and give great satisfaction wherever a large number of holes of equal or varying sizes are to be drilled simultaneously, as in the base of blast pipes, &c. There are also a large number of machines from the American Tool Works, of Cincinnati, in addition to the usual light types of hand-lever drills by various American makers, and by the Greenerd Arbor Press-Lever Company. Shapers by the American Tool Works are largely employed, and there are two single-headed slotters of different sizes by the Niles Tool Works, with the extra long tool slides characteristic of American slotters or shapers intended for very accurate work. These are also much used for slotting axle-boxes. An extremely simple key-way cutting machine for wheels, by Merill, of Saginaw, has been in use here for about three years, giving excellent results.

In the planer bay the machines are by the American Planer Company, the Powell Planer Company, the Cincinnati Planer Company, Gray and Co., of Cincinnati, and others. For all these tools electric motors are provided, but, in general, a belt is employed for the transmission.

The grinding department for cleaning up castings, &c., is not a particularly exhilarating place, by reason of the clouds of dust prevailing, and it is just for this reason that it has been placed apart from the rest of the shop. There are here about twelve grinders by Grafenstaden, Offenbach, Landis, and Garvin, employed for nuts, bolts, and castings, and each machine has a separate compartment to itself. Tempered cross-head guide-bars are ground up true in a department near to the tool room, the composition wheels revolving in safety troughs.

Wheel shop.—As is the general practice almost everywhere, excepting in the case of large steel works which build locomotives, the wheel centres and tires are obtained outside—the former mostly from Krupp's. Tires are turned up generally while mounted on the axle, and upon the usual type of duplex machine, having four tools at work simultaneously, and starting first with a roughing cut, and finishing off with a scraping tool, which latter gives the exact profile for the flange and tread. The safety-ring grooves are cut upon duplex lathes, and the cutting tool is kept cool under a copious supply of oil. The axles are forced into the centres by wheel presses, and the tires are mounted on their centres after having been expanded by gas burners. The safety rings are hammered on to the wheel centres by hand hammers.

Crank axles of the oblique type are now coming into use both for home and for export work. They have been employed notably in the very large four-cylinder express compounds recently built by Breda for the Roumanian State Railways, and are of a very neat round section, as shown in the view—Fig. 5. The body of this axle is cleaned up smooth, and usually finished with a coat of glossy red paint. As every pound weight which could be reduced in the Roumanian ten-wheeled locomotives was of importance, in order to keep the machine below the limit weight allowable upon each axle, the round-section axle was adopted, as it permitted some amount of reduction in the total weight. The latest series of Adriatic compounds now being built here also have oblique type crank axles, but are of rectangular section.

A quartering machine, by Güller and Zust, of Intra, is used for boring with accuracy the two wheel bosses for main-rod or side-rod pins of any desired throw in the two mounted wheels. Axle seats are milled out true by a milling machine, from Roberto Züst, of Intra.

Automatic tools.—By reason of limited space, these have been placed upon an upper floor, and, to save floor room, are arranged obliquely, according to the usual practice. This room contains nearly all American tools, many of these being for bolt and nut making, while there is also a very fine Hamilton lathe. The bolt machinery is by the Cleveland Machine Screw Company. A hexagonal bar of the size required for the heads of the bolts is put into the hollow mandril, and the work proceeds continuously until the bar is used up, both bolts and turnings falling with the oil into the frame trough. The turnings are afterwards treated in centrifugal machines for the recovery of the lard oil used.

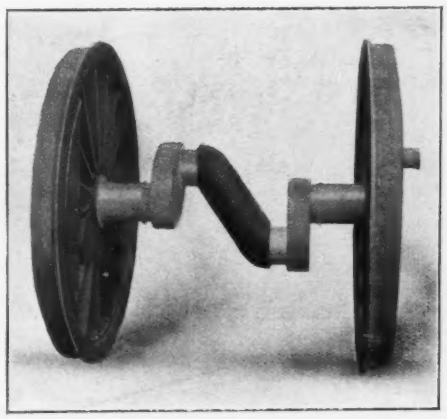


Fig. 5—CRANK AXLE AND WHEELS

For nut making the most notable machine is a sextuple vertical head automatic by the Acme Machinery Company, of Cleveland, Ohio, making all sizes up to 1¼in. A bar-cutting machine by the Davis Machine Company, of Rochester, is employed for cross-cutting pieces to lengths required. Barely to mention the many types of small machines of American origin used only in this room, even without description, is impossible here; but at the opposite extremity of the same room may be noted in passing a duplex copper stay-bolt making machine, the attendant for which can look after other tools at the same time. The bars of copper are cut to given lengths that have been measured specially for individual boilers, are passed through straightening rollers, and then, if so required, are bored upon a lever vertical drill, and in some instances—as for the Adriatic locomotives—are turned down in diameter at their middle, after which they are chucked and screw-cut for all or part of their length upon a machine which is said to finish the stays at one pass, as compared with six passes, which we have noted as being usual with ordinary screw-cutting lathes in some Italian railway repair shops. This machine screws an average of forty stays per hour of the Adriatic type—that is, having the middle part of their lengths of a less diameter than the screwed ends.

The centrifugal oil separators are placed in this shop, and also in other parts of the works where convenient, for the treatment of waste turnings and borings. These machines are by the Garvin Machine Company, of New York and Philadelphia. The separated oil is taken to an annexe of the oil-room, and there filtered for use over again.

Materials are hoisted to the first-floor machine-room by a lift actuated by cable and pulley from a 30 horse-power electro-motor, which serves also as the motive power for part of the tools in the shop named.

Small tools departments.—For the specially fine work of repairs to machine-tool parts, or the making of milling cutters, twist drills, &c., the works have a very complete equipment of tools, and we note two excellent machines of different sizes by the Brainard Milling Machine Company, of Boston and Hyde Park, for cutting gear wheels and such like accurate machining. Milling cutters are also made on tools by Smith and Coventry, which latter machines appear to be much esteemed for the results they give. There are also tools by the Pond Machine Company, and a slot-cutting machine for shafts, with automatic movements, from Bement, Miles and Co., of Philadelphia.

The repairs to worn tools goes on in another part of the works convenient to the machine shop, in a department shut off in the usual way and provided with the customary means for checking tools received and tools delivered. Tool repairs, tool grinding, and tool storing are three departments suitably divided, all jobs from the shop being passed in through the latter office, or else through the grinding-room by means of small pass-holes in the nettings which surround the counters.

The screw-cutting lathes of the Hendey Machine Company, of Torrington, Conn., so common in nearly all continental works, and also the fine grinding machines—for twist drills, &c.—from the Waynesborough Tool Company, Penn., besides tools of other American makers, are employed in this department.

Erecting shops.—This shop is hardly equal to modern requirements, but it has served its purpose very well up to recent years. Locomotive parts are brought here, and the locomotives, when completely erected, are shipped hence to the painting shop on a transfer table. The table is provided with a 25 horse-power three-phase motor, the current for which is picked up as the table moves. This building accommodates twenty-six locomotives, and those certainly among some of the largest yet built in Europe. Inside the shop is served with two 25-ton cranes driven by means of cables from a 15 horse-power electro-motor placed at one extremity of the shop. The bays on the other side of the arches are occupied by drills and other tools indispensable in erecting shops. The system of erection followed is that of assembling each individual part separately on the locomotive itself. Hornblocks are now bolted instead of riveted as formerly. Occasionally for some railways the bolt shank is given a slight taper near the head, to ensure a very tight fit.

Central store.—A systematic system of checking work in its various stages of progress is employed. It consists in passing the work from hand to hand by the intermediary only of the stock-room, the sole exception thereto being for very large pieces in preparation for work upon order, and then, in this case, on account of the weight, the verification of the work done is effected upon the spot, the templates, or other form of gauges required then being permitted out of the central store—which is both a stock-room and a gauge-room. Each time that materials are handed out, a *bon* or voucher is given with the job and has to be returned for booking. If the voucher is not brought back no payment is made for the piecework done. All the full-sized blue prints are also kept in the stock-room for work actually in progress, and are handed out as they are required in the shop. This store requires the services of four chief gaugers, four clerks, one engineer, and a varying number of workmen dependent upon the work of storing actually going on in this department. When work comes in here it is gauged, and, if need be, tested; for in the same room are kept all templates, calibres, gauges, master gauges and screws, jigs, and instruments of every kind for testing, measuring and weighing, as well as all instruments or tools for laying out work. The templates for engine frames are also kept here and taken into the shop for scribing the frame plates after they have been roughly slotted to shape on the machine. There are about eight large heavy plates or tables in this store for setting out work, surface gauging, &c., and the men employed in this department are, of course, experts in their occupation. The shop manager has, for his own reference, blue prints filed, in book form, in his own large shop office—situated in the machine shops—and others are laid out upon a table in front of this office for consultation at all moments. A properly-fitted warehouse for finished parts of every kind, and also for complete machines, is situated in another part of the premises, but work from the shop is only transferred there when not required immediately in the shops.

Such fittings as Hausshälter indicators, Coale pop valves, brake equipment, and other specialities are obtained outside and stocked here in this warehouse, and are given out as required to the central store previously described.

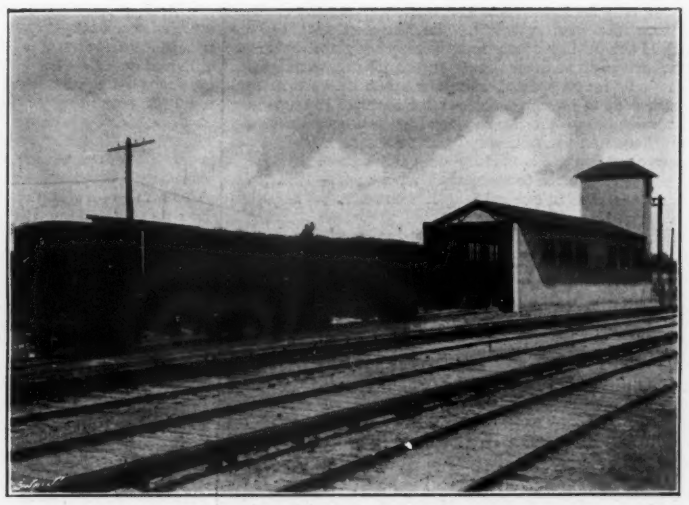
Annexe for engine erection and tender construction.—This is a very large new building divided from the main edifices by a public road, but having communication with the latter by means of the 32ft. electric transfer table previously noted. The entrance to this annexe is closed by a 40ft. wide lifting or curtain door, upon the bottom of which are fixed insulated strips of copper, which, when the door is raised, complete the circuit of the three-phase current wires.

The appearance of this building is novel, the interior walls of red brick supporting the roof spans being formed of lofty arches, above which are built other rows of arches or openings, so that the greatest possible amount of illumination is distributed throughout the shops from the roof lights. The main "tender" bay is served by a 25-ton fast-speed travelling crane of the latest Oerlikon model travelling at 112ft. per minute, traversing 27ft. per minute, and lifting at 5½ft. per minute, each movement having its own electro-motor. In the bays, to the right-hand side of the "well" for the transfer table, are placed all the tools for shearing, edge planing, punching, drilling, milling, &c.

* No. I. appeared December 15th.

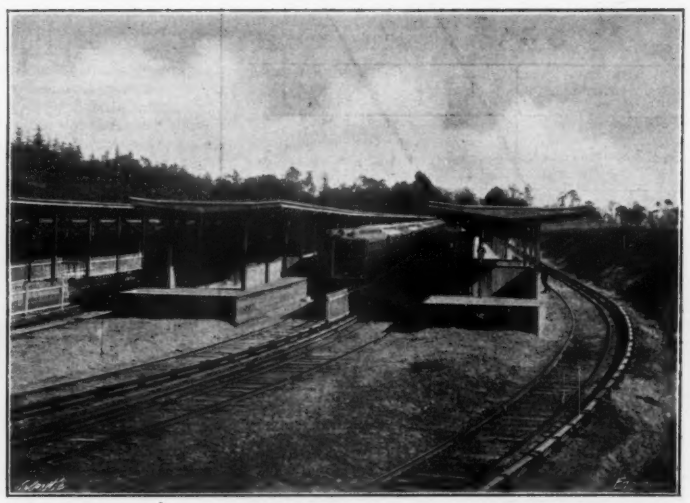
LONG ISLAND ELECTRIC RAILWAY

CONCRETE HOUSE FOR PORTABLE SUB-STATION



PORTABLE SUB-STATION

CROSSING NEAR NEWHAVEN JUNCTION



BELMONT PARK STATION

A great part of the tender shop is occupied in the construction of new locomotive boilers upon order for railway companies' shops, and in work upon old locomotives actually under repair here—for this business also is done by the Elvetica Works—and some space is occupied by portable engines which are built and tested here, where they stand, so that for all this work a fairly large installation of suitable tools has been provided, in addition to those ordinarily necessary for tenders.

Carriage building works.—Railway coaches of the largest size built in Europe are also made here for the steam and electric lines of Italy. The principal railway carriage and goods wagon builders in Italy competing for this business are the firms of the Officine Meccaniche di Milano (Miani, Silvestre and Co.), and Diatto's, of Turin—both establishments being well equipped for such work; while there is, besides, the Società Nazionali della Officine di Savigliano at Savigliano and at Turin.

When not in full employment with locomotives, carriages, or wagons, the works of Breda turn for stock work to the manufacture of threshing machines and portable engines—similarly, in fact, to the plan followed at Budapest by the Hungarian State Railway Works.

At the Elvetica Works, on account of lack of space, the carriage builders' shops are partly covered over by an upper floor, serving for model makers, cabinet-makers, and for light wood-working tools, and here also the the sheet iron cabs are brought for the lining of their roofs with pitch pine.

Inside the works there is a fully-stocked timber yard, and saw mills equipped with Kirchner (Leipsig) jig-frame saws and Robinson band saws. Timber is stocked for seasoning for a year or eighteen months, and then cut up and kiln-dried for forty days, during which process the wood loses 20 to 30 per cent. of its weight.

The threshing machines are made in all sizes from 28in. up to 54in., and the portable engines are constructed in all small sizes of from 2½ to 8 horse-power nominal.

The models of both kinds of machines resemble very closely the English in general arrangement.

Painting shop.—This accommodates twelve locomotives without tenders, heating being effected by stoves.

Power.—The motive power for the shops is obtained through electric current from the Edison hydraulic station at Paderno. Current arrives at the city central station at 13,500 volts, to be transformed to 3500 volts, and then again stepped down at Bredas to 160 volts. For lighting there is a separate motor in Bredas electric station. The total capacity employed when in full work is 1000 H.P.

Drawing offices.—These are very fine, large offices, with lofty wagon-top ceilings. They are illuminated by high windows, screened in the summer by yellow blinds. The rooms are fitted up with the usual chests of drawers, in which are classified all the drawings of various home and foreign railway companies, according to their types. The drawing-table tops are very heavy, and are supported upon correspondingly heavy trestles. Incandescent electric lights are suspended in rows from the ceiling for general illumination, and each man has his own pedestal green-shaded lamp.

Upon the tables in the summer-time are numbers of portable fans, run by ¼ H.P. electro-motors, which each draughtsman can place to suit his convenience. For heating in the winter there are six sets of steam heating radiators. The chief draughtsman's office immediately adjoins this room. In this official's library we note that matters describing locomotives printed in foreign publications are at once cut out and placed in portfolios having sketched on their covers the numbers of pairs of wheels as a rough indication of their type.

The general offices are below, on the first floor, and photo-printing is done upstairs on a terrace, commanding an exceptionally fine view of the Alps and Pre-Alps, and therefore having a very good light for the work, so much so that the light entering the room for changing the cyanotype heliographic or sepia paper has to be filtered through a strong yellow medium.

Besides the regular drawing-offices, there are offices over the shops themselves, where dimensioned freehand sketches are made and kept for every small piece whatsoever, and especially for forged pieces that are manufactured at the works. These are numbered, and put up into book form, serving very well for shop guidance, and are easily consulted, without the need for making reference to the blue prints in the central store previously mentioned.

Locomotive building was commenced at the Elvetica Works in the year 1878, and the present annual capacity of that establishment is 100 locomotives, while the number of persons employed when in full work is up to 3000. The new works of Sesto, San Giovanni, are occupied exclusively in the manufacture of rolling stock, such as carriages, vans, trucks, and electric tramcars.

The Pennsylvania Railroad Company moved 185,000 freight cars over its main line in November, and claims to have thus established a new record. Of these cars 111,940 were loaded.

ELECTRIFICATION OF THE LONG ISLAND RAILWAY.

One of the most interesting of the many engineering works now in hand in, and near, New York, is the conversion of the Long Island Railway from steam to electric propulsion. As is generally known, New York proper is on the island of Manhattan, to the south, approximately, of which is the Atlantic Ocean. On the west is the Hudson or North River, and on the east is the East River. The Harlem River is on the north side, but this is only a small stream as compared with the North and East rivers. Residents have thus to seek homes in three directions. On the west is the State of New Jersey, where many live. At present they have to cross the river by ferry, but the North River is now being tunnelled in at least three places. Access to the north is obtained by rail from either the Grand Central Depôt in Forty-second-street, or by the subway which commences at the foot of the island, and runs for several miles out in a northerly direction on both sides of the island. On the east side, across the East River, is Long Island, on which is built that part of greater New York known as the borough of Brooklyn, and Long Island also contains such well-known places as Coney Island and Manhattan Beach. Access to Long Island is at present obtained by ferry, or by the two Brooklyn suspension bridges. A third bridge is now being built, also an extension of the subway from the foot of Manhattan Island to Flatbush-avenue in Brooklyn.

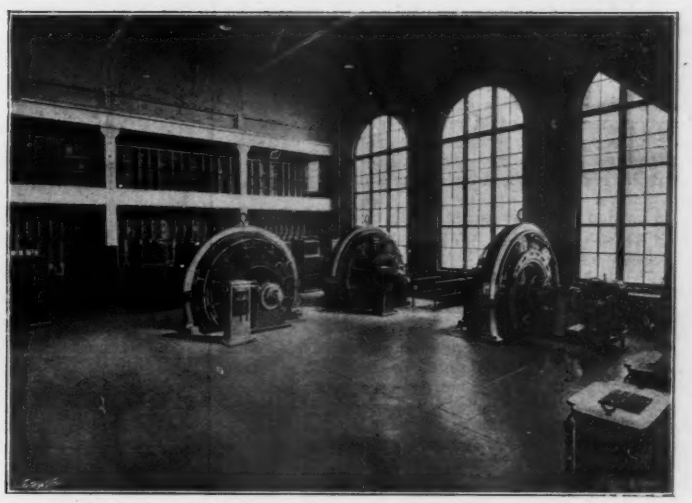
Thoroughly to understand this subject, it must be further stated that the Pennsylvania Railroad has no physical access to New York. Its terminus is at Jersey City on the New Jersey side, and consequently all the New York patrons of this important road have to cross and re-cross by ferry. This is now being remedied by the construction of a tunnel under the North River, and a huge terminal is now being erected in New York in the centre of the shopping, amusement, and hotel district. This work, it will be of interest to state, is being executed by S. Pearson and Son, Limited, of Westminster. The new line will be continued right across the Island of Manhattan, and under the East River into Long Island, and there join the Long Island Railway. It may be remarked here that the power-house for the scheme now about to be described is situated near the point on Long Island where the entrance for the East River tunnel will be. The Long Island Railway has a physical connection with the Brooklyn Rapid Transit lines serving Brooklyn Bridge. This is an electric trolley car line whose cars

LONG ISLAND ELECTRIC RAILWAY

STRAIN POLES AT TRANSMISSION LINE CROSSING

TRUNK TRANSMISSION LINE

STEEL MOTOR CAR



EAST NEW YORK SUB-STATION

run over portions of the Long Island Railway. The cars from the subway, when completed, will travel over the tracks of the Long Island Railway; as will also trains from the new Pennsylvania tunnel. In this scheme, therefore, there are interested, and have to be considered, not only the Long Island Company's own requirements, but the Pennsylvania, the Subway—known officially as the Interborough—and the Brooklyn Rapid Transit.

From the foregoing it will be understood that Long Island has a large residential population. It possesses, too, many popular resorts, such as Coney Island, and has three well-patronised race tracks. These two latter features, however, only provide fluctuating conditions which are not regular and systematic. They must yet be provided for in the scheme, and the maximum possible conditions have had to be foreseen. The railway company, however, determined to provide complete electric service in the hope that the better service would have the same effect as the conversion of our Lancashire and Yorkshire Liverpool-Southport line, viz., to popularise the line and increase the number of patrons, and particularly permanent residents.

The equipment of the whole railway having been decided upon, the first portion to be converted was from Flatbush-avenue to Belmont Park and from Woodhaven Junction, across Jamaica Bay, to Rockaway Park and the connecting line *viâ* Valley Stream, a total distance of 42 miles, and equivalent to a mileage of single track of 97½ miles, when the third and fourth lines and sidings equipped are included. Of the 42 miles specified, traffic is now being operated on the new system for 23 miles, whilst the remainder of that portion will be completed this winter. As has already been said, the power-house is situated in Long Island City, near the point where the Pennsylvania tunnel emerges. This is not a central position for the work on the Long Island, but as it is proposed to obtain therefrom all the power for operating the new tunnels under the North and East rivers for the Pennsylvania Railway and that company's large new station in New York, it will be appreciated that the position is excellent. Like the District Railway's power-house at Lot's Wharf, it is built at the water edge, as seen on page 639. It is believed to be the largest in the world, and is entirely equipped with steam turbines. There are at present three Westinghouse-Parsons horizontal turbine units of 5500-kilowatt capacity each, and space is provided for three others of the same capacity. The building is 250ft. wide, 300ft. in length, and 120ft. high. The chimneys are of steel. There are thirty-two water-tube boilers of 520 horse-power each, in a double tier of sixteen boilers each, and space has been reserved for a further sixteen. The coal-handling apparatus, seen in the foreground of the exterior view, will convey coal from barges into bunkers inside the building. "Clam-shell" buckets, holding 3000 lb. of coal each, travel up the tower to breaking and cleaning apparatus at the top. Thence the coal drops into steel hopper cars, and is taken into the building.

From the power-house the three-phase alternating current is conveyed in conduits through the more densely populated districts. Thence the cables are carried overhead on specially designed steel lattice poles, as seen above. These poles average 45ft. in height, and are set in concrete foundations. They are fitted with heavy wooden cross-arms, to which porcelain insulators are affixed by steel pins, and a special design of stirrup-clip that surrounds the cross-bar but does not pierce it. Where the transmission wires have to cross telegraph or telephone wires, the latter are led under and the poles are placed closer together. Owing to the heavy and strong construction of the transmission line fear of breakage and damage to other wires is removed. Where the wires are led from overhead into conduits, and *vice versâ*, special arrester and cut-out houses have been provided to guard against danger from lightning.

There are five sub-stations. The largest of these is at Woodhaven Junction, and there the current is stepped down from a potential of 11,000 volts to about 400 volts by nine static transformers of 550 kilowatts capacity each. From these it is led to three rotary converters of 1500 kilowatts each, which convert the alternating current to 600 volts direct current, at which potential it is led to the third rail. The accommodation at the other sub-stations is less in quantity and power, but as the demands of the traffic increase the present equipment will be replaced by plant producing greater power, and the existing equipment will be removed and placed in additional sub-stations. At the south end of the line, on the shores of Jamaica Bay, there is a sub-station at Hammel. This is provided with an additional equipment of a storage battery of 2000 kilowatts capacity, making it the largest storage battery for railway work in the world. This provision has been prompted by considerations of both service and economy. The economy lies in the fact that during the winter months the rotary converters may be closed down for most of the time, and reliance placed on the storage batteries. Their use, too, strengthens the service, as it is the furthest point from the power-house, and the transmission line is exposed to an unusual extent for the four miles across Jamaica Bay. All the sub-stations are similar in appearance and construction. They are built of brick and steel, and of fire-proof material throughout. The rotaries and transformers are on the first floor, and the main switchboard is on a gallery from which the operators have an uninterrupted view of all the machinery under their control.

Whilst not novel, an interesting feature is the use of portable sub-stations, consisting each of a 1000-kilowatt rotary converter and three static transformers carried in a steel car. These may, for instance, be sent to some point where the traffic is temporarily abnormally heavy and connected up, and this additional power is found convenient on such occasions, as no feeders are used for supplying the third rail, the high conductivity of these rails permitting of feeders being dispensed with for all ordinary conditions of traffic.

The third rail is laid 27in. from the gauge line of the track to the centre line of the third rail, and the top is 3½in. above the top of the running rail. It is carried on insulators of vitrified clay attached to every seventh sleeper, which has been extended beyond the line of track. The third rail is protected by a wooden sheathing, 2in. thick and about 4in. above the rail. At stations side protections are also provided, so that no one can touch the third rail except by inserting the hand or toe into the space left for the contact shoe to travel in. At level crossings the third rail is omitted, and trains are carried over by their momentum. The ends of the third rail are made into a broad, sloping shoe, and the cable is carried in a duct sufficiently deep under the crossing not to be interfered with by repairs to the crossing.

The trains are to be composed of motor and trailer cars, a motor car always being at the end, and the proportions being two motors to one trailer, or three, or two, or five motors to three trailers, a trailer always being placed between two motors. The cars—seen in Fig. 5—are of all steel, designed by the chief engineer of electric traction, Mr. George Gibbs, and manufactured by the American Car and Foundry Company. They are equipped with the Westinghouse pneumatic multiple-unit system of control, and each motor car has two propelling motors of 200 horse-power each. These cars are similar to those in the New York subway, and whilst the conditions to be found there are the same as to limited height, clearance on curves, high speed and frequent stops, maximum strength combined with smallest possible weight, yet they were more exacting for the Long Island stock, which not only had to interchange with the subway stock, but when they were in the country districts the passengers had to alight on the ground, and not on platforms on a line with the

level of the floor of the car. This has necessitated the design of a special platform for the car, which is the full width when running in the city limits, and yet provides a pair of steps when out in the country.

The motors are geared for a speed of 55 miles per hour. The cars are equipped with the Westinghouse graduated release triple valve, which brings the train to a stop in the same even manner as it obtains its maximum speed under short headway—without jerk or jar.

The work is being carried out by Westinghouse, Church, Kerr Co., of New York.

CONFERENCE ON SMOKE ABATEMENT.

No. III.*

On Friday morning, 15th inst., the chairman was Sir William Richmond, K.C.B., and the list of papers was as formidable as it had been on Tuesday and Wednesday. The same course, however, was adopted as on the first two days, and the papers were taken as read.

In his address, Sir William Richmond said that both the ethic and the æsthetic sides of the question had to be taken into account. They were, in fact, merged together. Light gives life and colour. In plants, if they are grown in the dark, there is no colour at all; they become white. Pictures, on the other hand, become black, or at least deep yellow, if they are kept shut up. The old masters were well aware of this. Rubens, in sending away a picture, wrote asking that when it arrived it should at once be opened and placed in the sun, so that it might recover its clearness and colour. Titian placed his pictures to dry in the sun, and left them out all night, so that they might be acted upon by the morning dews and mists. "I have tried this experiment in London," said Sir William, "with disastrous results." Forty years ago a Royal Commission sat to consider the desirability of transferring the national pictures to South Kensington. One of the chief witnesses whose evidence was taken was Faraday. He said that every smut which remained even for the briefest of periods on a picture left behind it some greasy matter which could only be removed by means of such a strong solvent that there was danger of its reaching and rotting the fabric on which the picture was painted. Man is affected by light and dirt very much as is a picture.

In London frescoes were practically impossible. If there were noxious gas in the air, the lime of the plaster was acted upon, and, in time, the whole of the surface is disintegrated, and can be rubbed off. For water frescoes the wall must be perfectly dry. Then, just as the painting is to be done, a thin layer of lime and marble dust is spread over it. The painting itself must dry with this layer of plaster. Only the purest water obtainable must be used, and even that must be boiled beforehand. Water, and perhaps wine and weak vinegar, were the only permissible liquids to employ. Lime is always the binding material, and coal smoke is fatal to the proper setting of lime. The reasons why frescoes did not succeed was that either noxious gas had been present, or there had been failure properly to incorporate the pigment with the lime. They were still possible in the country perhaps, but in London impossible.

Then, as regarded marble and bronze statues. The former pulverised under the action of coal smoke. Priceless works from Egypt and Assyria were slowly disintegrating in the British Museum. Washing them with water was of no avail. This liquid failed to wash away that which was doing the harm. The only possible thing to do was to keep them in hermetically sealed glass cases. Manuscripts were subject to the same trouble. Bronzes were not quite so bad, but all metals, even gold, were to some extent affected. All the stone in London was being acted upon. All the window sills in St. Paul's Cathedral were coated, both inside and out, with a thick layer of acid soot. In the National Gallery and the British Museum there were collections worth millions. The private collections contained many priceless works of art. Is it wise to permit the work of destruction to continue? Cannot something be done to compel Parliament to legislate on the matter? asked Sir William.

Of course, sometimes too much discussion only ended in smoke, but action by the Government might be enforced by pressure from outside. Unanimous public opinion is the Government, because no body of ministers dare go against it. Any Bill brought before Parliament on the subject must be most carefully watched, so as to prevent its being clipped here and there and robbed of its value.

Sir William concluded his address by urging every one to help on the good cause by joining the Coal Smoke Abatement Society, which was doing such a good work, and which was, mainly at all events, made up of members who had no axes to grind.

He then called upon Sir John Ure Primrose to make a few remarks regarding the paper which he had submitted to the Conference. Sir John said that his paper was a plea for a systematic comparative analysis of the air of towns, and a consolidation of the law dealing with smoke emissions. Glasgow had for some time been carrying out analyses, and the results obtained were very interesting. As an instance of this, Sir John cited an occasion when an analysis of the air taken during a day's continuous rain had shown that the air was free from acid vapour. A few years ago an analysis would have shown acid present in alarming proportions, but the proper enforcement of the Alkali Act had entirely removed it. But the smoke remains unchecked. He maintained that continuous analyses of the air and of smut fall should be maintained in every town, and the data so obtained should be brought together so that all might work in consort.

Smoke could be done away with. He had succeeded in the case of his own works, and anyone who really meant to help could, if they were so minded, make a great change in the amount of smoke emitted. It was a pity that they were not compelled to do so. Nottingham was, he believed, the only town possessing a by-law which said that smoke must be prevented. There they made the stoker liable with the owner. He himself would like to see the careless workman made liable universally, then, with a consolidation of the law and with the data which he proposed should be obtained, they might hope to enter on a period of, at all events, possible improvement.

Sir John's remarks very fairly outlined his paper, but we may make the following extract:—

> It is manifest that the atmosphere of a manufacturing town cannot be fairly compared with the atmosphere of a purely residential town, nor can the air of a residential town be compared with that of a country village or hamlet. Three standards seem to me to be necessary to be established before any one is entitled to say that the citizens of this city or that town are unduly suffering, either in their health or in their amenity, from a smoke-polluted air.
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> Now, it is a curious circumstance that, while we have standards for many things—viz., sewage and manufacturers' effluents, acid and other noxious exhalations from works classed under the Alkali Acts, the amount of water and fat in milk, the quantity of butter in margarine, the quality of drugs and such like—we have not yet arrived at even the serious consideration of a suitable standard for city or town air. Air, in which we are, so to speak, bathed—submerged from morning till night—and in which "we live and move and have our being," may be anything so long as it can be breathed at all, with the exception I have named—viz., the provisions of the Alkali Acts. Doubtless there are also the public health provisions affecting what are termed "unwholesome trades," and local authorities are authorised to make by-laws prohibiting the contamination of the atmosphere by noxious effluvia from such works. In both of these cases the sense of smell is offended, and the nuisance is palpable.
>
> In the case of a smoke-laden air this is not the case to any serious extent, except when fog is present to complicate the situation. Nevertheless, we have both medical and other evidence that a smoky atmosphere is inimical to health, conducive to depression, and destructive of plant life, as well as of building material.
>
> In the face of this evidence, and our own experience, we ask "Why is there no standard for a town's air with reference to smoke pollution?" The answer appears to me to be a simple one, and it is this: The town dwellers are ignorant of the extent of the pollution, and sanitarians and scientific men have not yet made any systematic investigations in the cities of the kingdom with a view to enlighten them.

The next paper dealt with was that by Mr. Julian S. Corbett, and was entitled "A Note on the Proposed Amendment of Sec. 24 (Sub-sec. 6) of the Public Health Act (London), 1891." In introducing the subject, Mr. Corbett remarked that by reason of the baneful effect of the recent coal-smoky fogs on his lungs, he was much more fit to be an exhibit in the exhibition than to address a meeting. His paper really aimed at drawing attention to the kind of difficulties likely to be met with in making any alterations to the present laws. It attempted to apply the usual difficulties of legislation to the particular matter in question. There were two ways in which procedure might be made. We might either nibble or we might make wholesale demands. He advocated not too precipitous action.

He then turned to Sec. 24 (Sub-sec. 26) of the Public Health Act, and discussed the difficulty of arriving at what really was "black" smoke. Any magistrate, he remarked, who was not in sympathy with the smoke abatement movement would have a very different view of what was black smoke from a magistrate who was in sympathy. Again, it was all very well to suggest prohibiting the emission of "smoke in such quantity as to be a nuisance," but the difficulty was to prove the nuisance, and all lawyers knew that there were few things in law more difficult than that. Then there was the other suggestion which aimed at the prohibition of "black" smoke.

Whatever course was decided upon, they must be sure of being able to enforce the restrictions laid down. Unless they were prepared to say what should be done to prevent the smoke, no amount of legislation would help them. In France smoke was absolutely prohibited. It was simply said that there should be no smoke. What was the result? The law was a complete failure. Dresden, on the other hand, forbade the emission of smoke containing any visible particles of soot. There they took care that the law should be effective. They had established expert teaching for stokers and expert advice for users. The advantage to their pockets which would accrue if smoke were stopped was pointed out to the latter. If drastic measures were to be proposed, then they must be accompanied by sympathetic aid. People must be helped to obey the law.

From Mr. Corbett's paper we may, we think, usefully take the following abstract concerning Dresden, which goes more deeply into the matter than was possible in the short time given to the author when introducing his paper:—

> In Dresden, however, a city which has long been noted as an example of amenity in civic management, we find that as far back as 1887 a by-law was enacted which goes beyond anything we have ventured even to propose in London, or elsewhere in the three kingdoms. It runs thus:—"In all manufacturing and industrial premises the construction of the furnaces must be of such a nature and their stoking so regulated that no smoke containing visible particles of soot is constantly emitted." "Where this happens only occasionally and exceptionally, the nuisance must not last longer than is absolutely unavoidable even with the most careful stoking and the employment of coal of at least medium quality."
>
> Two years were given as a period of grace to existing premises. But the Dresden authorities were not content even with this drastic dealing with industrial premises. They extended their hand against private premises as well; and the by-law further provided that "in private dwelling-houses the heating arrangement must be so contrived as to produce as little smoke as possible."
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> To forbid black smoke absolutely, and coloured—visible—smoke almost entirely, appears to go very far, but the step was taken not unsympathetically. At the same time an official inspector was appointed, whose duties were not only to enforce the law, but to assist citizens in complying with it. Besides reporting offending premises, he was to hear all complaints against "the practicability and onerous nature of the by-laws." He was to inquire into and suggest improvements in means for combating smoke, and he had attached to him an expert foreman stoker, who assists him in his duties, and "is frequently called on to give practical illustration of the effect of skilful stoking in reducing smoke."

Mr. Joseph Hurst was next called upon. The title of his paper was "English Law relating to the Emission of Smoke from Chimneys." It contained, he explained, the facts established by law regarding the subject of smoke. He discussed the retaining of the word "black" in the sub-section, and the making the emission of black smoke *per se* a nuisance, and said that his paper contained decisions on this point. Then on the subject of nuisance, Mr. Hurst said that it was impossible to be too definite. If the question as to whether or not certain emissions constitute a nuisance be left open, then difficulties are sure to be met with. As an instance, he drew attention to the chimney of the destructor on the south side of the river opposite the Temple. This, he remarked, was always belching forth smoke, which though never black was always a nuisance, and, when the wind was in the right direction, frequently made things very unpleasant in the Temple.

From Mr. Hurst's paper we take the following extract, which deals with the emission of smoke from domestic kitcheners or grates:—

> It will be observed that up to the present time no legislation has been attempted with the view of minimising smoke from domestic kitcheners or grates. The height of buildings, &c., affecting the access of light and air have been the subject of drastic enactments; but the domestic kitchener or grate, which by the smoke it sends forth enormously affects light and air, has, so far as legislation is concerned, been left to work "its own sweet will." This seems inconsistent with the principle which one would assume underlies legislation, under which domestic appliances in connection with water, gas, electric current, &c., have been the subject of jealous regard, and are the objects of frequent domiciliary visits, even in the neighbourhood of the domestic hearth. It is to be hoped that as a result of the inquiries now being carried on by the Coal Smoke Abatement Society, with the assistance of the Office of Works and others, a domestic grate may be discovered which shall, by improved combustion, prevent, at least, black smoke. When such a grate is discovered, legislation will be not only desirable but opportune, by which there may be secured to the consumer more beneficial use of fuel, and to the metropolis and to large provincial cities and towns brighter and cleaner atmospheres.

Mr. Chubb, the Secretary of the Coal Smoke Abatement Society, then rose to say a few words regarding his paper. He said that he had endeavoured to condense in it the mass of valuable data which had been supplied in answer to their inquiries by no less than 205 authorities. He was afraid that condensation had been so rigorous that those who had supplied the information would feel that they had been badly treated. To these he apologised, but he had been bound to condense in order to keep the length of his paper within reasonable bounds. One of the most remarkable facts brought to light had been the apathy displayed by most authorities. This was, without doubt, a reflection of the apathy displayed by the Local Government Board, and was not, perhaps, to be wondered at. It was not the Local Government Board which had prevented the emission of smoke from factories round Kew Gardens. This had been left to private enterprise, and in it Sir William Richmond had had a large share. Another point worth mentioning was that many local authorities seemed to think that black smoke indicated "work," instead of what it really was—"waste." He suggested that it might, perhaps, be possible to make them see this. The percentage of cases in which statutory notices had been served by local authorities was very small. The authorities seemed to think that their duties were over when they had appointed inspectors. The reports were simply docketted and pigeon-holed. It was pointed out in many cases it was impossible to obtain convictions, because the magistrates themselves were frequently works owners and the principal offenders.

Some of the authorities in sending in their replies to this question had made proposals. One was that a standard should be set up for the emission of smoke. "We can't tell what *is* black smoke," they said. "Give us a definition, or let the Local Government Board do so." He himself ventured to think that there was something in this proposal. Then others suggested time limits, such as (1) continuous emission for eight minutes, and (2) two minutes' emission in any one hour.

The time had come, he thought, when some attempt should be made to deal with the smoke coming from large mansions, many of them having a common kitchen and sending out a body of black smoke which was as bad as that from any factory chimney. And the time had come, too, when the Government should be compelled to obey the law in this respect, as well as other people, and he instanced the very large amount of smoke sent out from the chimneys of Woolwich Arsenal.

From Mr. Chubb's paper we make the two following extracts:—

> One of the most disquisting features manifested by the information supplied under this head is the small percentage of cases in which statutory notices have been served, and subsequent proceedings initiated by local authorities. In the provinces, after deducting the cases dealt with by Liverpool, Manchester, Glasgow, Birmingham, Bradford, Nottingham, and Sheffield, there still remain 6182 reports of black smoke nuisances. In 2087 instances letters of caution or statutory notices have been served, and apparently the letters of caution far exceed the statutory notices in number. Only 164 prosecutions were undertaken. In the metropolis only 897 statutory and 394 intimation notices were issued in respect of 4355 cases, and the prosecutions amounted to 61. It is obvious that if local authorities do not follow up reports of smoke nuisances by serving statutory notices and initiating legal proceedings, the nuisances are not likely to be abated. Several Councils state, in extenuation of their inaction, that it is hopeless to secure a conviction, as the members of the Bench adjudicating are themselves often offenders in the matter of smoke nuisances.
>
> To sum up, the returns disclose that while the black smoke evil is very generally felt and deplored, relatively few local authorities have in the past taken a decided stand in the matter, and that while this inactivity may sometimes be traced to apathy, it is more often due, not to any inclination to evade responsibility, but to a feeling of hopelessness, in view of the uncertainty of obtaining convictions. Where authorities have taken a decided stand, however, even with the imperfect machinery at present available for the suppression of smoke nuisances, it is only fair to say that they claim to have diminished the evil. Little improvement or zeal can be looked for until the law is simplified and extended, and a more summary and effective method of procedure provided. It is, perhaps, not too much to hope that the Local Government Board, in view of the suggestions made by important Corporations, may see its way to clothe local authorities, in the immediate future, with the further powers for which they ask.

Mr. T. G. Dee, sanitary inspector of the City of Westminster, then made some explanatory remarks concerning his paper on "Smoke Abatement from the Sanitary

* No. II. appeared December 22nd.

Inspector's Point of View." The paper briefly sets out the position of the sanitary inspector regarding smoke emissions, and his lot does not appear to be entirely happy. On this point the following extract is apposite:—

In the witness-box, under cross-examination, the weakness of our knowledge of a special method of combustion was frequently shown up in strong contradiction to the expert who was certain that the smoke the inspector had seen could not be sent forth from the furnace he had constructed, as the admission of air was perfect; or that the mechanical stokers could not supply the coal so badly. One or the other mechanism was absolutely infallible, and he—the expert—was also certain that the particular furnace was constructed so as to burn, as far as possible, all the smoke arising from such furnace. Under such circumstances is it to be wondered that the magistrates are loth to inflict the cumulative penalty? Is it not most probable that, after duly discounting the expert's evidence, he who has spent the whole of his life in the study and prevention of smoke nuisances knows more about the "as far as practicable" than the sanitary inspector does? Thus, rarely is a fine of more than £10 obtained for any one offence, and then, if obtained, only after adjournments, again to take observations. During this period great care is exercised, and no smoke sent forth. Under these circumstances the very usual practice now is to proceed under the easier clause, which makes it an offence to send forth black smoke, from certain chimneys, in such quantity as to be a nuisance, as no evidence of construction of furnaces, or to consume as far as possible the smoke, is admissible here.

The sanitary inspector's power is confined to black smoke; on the emission of grey, blue, brown, yellow, or white smoke, in whatever quantity, he has nothing to report. What, then, is the quantity of black smoke emitted which constitutes a nuisance? Mr. Dee submits that the quantity emitted depends on two factors — the density, and the length of time the emissions continue. "Obviously," he remarks, "an emission of smoke, black and as dense as it is possible to conceive, for a period of, say, one minute, can be equalled in quantity by a black smoke, which appears against the clear sky to be grey, if the latter be continuously emitted for, say, half an hour. A conviction is most easily obtained when the inspector can testify that the emission was dense black smoke, and under these conditions short emissions of, perhaps, three minutes more often obtain convictions than a less dense smoke for a much longer period. Mr. Dee contended, in conclusion, that it was not the inspector who was to blame for the condition of London atmosphere, and urged that what was wanted was that more pressure should be brought upon the Legislature to give fuller powers against the evil.

The last paper considered was that by Mr. Wm. Nicholson, at present smoke inspector in Sheffield, but shortly, we understand, about to proceed to India to take up a Government position of a similar character, who was prevented from attending the Conference in person. The title of his paper was "Smoke Nuisance Inspectors and their Difficulties."

From this paper we extract the following:—

The general public need awakening to the enormous damage being done by the smoke nuisance, and especially the working-classes, who are the greatest sufferers, because they are compelled to live in the districts where the nuisances are the worst. If they realised the damage being done to their health, which is their capital, they would cry out with united voice and demand an abatement. If the local authorities will not accede to the demands of the suffering public, then they ought to petition and press Parliament to action on this question which has been ignored by them for so many years. If Parliament were to move in the matter, they would quickly move the proper authorities to action on the lines suggested or better, with advantage to all. If all were done that could and ought to be done, the results would be remarkable. There would be less dirt in the air breathed, lungs of a more pinky than coal colour, more sunshine, better health, cleaner clothes, cleaner buildings, and benefits too many to mention. Such results are within the province of practicability, and it is the duty of every person who cares for his own health, the health and wealth of the country, to join those who are engaged in this great warfare against the smoke fiend, and to use all the powers he possesses in bringing to an end a nuisance which is a disgrace to a civilised country and ought not to be tolerated.

Mr. Nicholson also proposes the creation of a board of experts to determine what is and what is not a statutory nuisance. This body he recommended should test smoke preventing appliances and processes suitable for boilers, furnaces, and fireplaces, and find out what smoke was necessary under various conditions of working.

The general discussion on these papers was opened by Mr. A. J. Martin. He said that he was by no means certain that more legislation was required. The trouble was not so much lack of power as superfluity of apathy. He endorsed the statement that education on the matter of smoke prevention was a necessity. He was disappointed not to hear some remarks from Mr. Nicholson, who had proposed the creation of a board of experts. Whether it was liked or not there was certain to be legislation.

In Bills by gas companies or power distribution companies, there would be clauses of far-reaching importance, not in the public interest, but in that of the proposers or the opposers of the Bills. Parliament has to legislate on intricate things. It should, in his opinion, be aided by a strong body of scientific men. He did not approve of the laws which simply said "thou shalt not," without any explanation of how you were to avoid doing so. Both the gas and electric lighting industries had been impeded by heavy restrictions, and, consequently, many of the undertakings of this character could not afford to spend money on consuming their smoke. He would like to see a tax levied on bituminous coal.

Mr. Frederick Cleeves also felt that what was wanted was education. He was certain that in this direction the proceedings of the Conference would have done much good. But before the British public submitted to anything, it wanted to know why it had to do so. Now, a man had no more right to poison another man with coal smoke than he had with arsenic. The first duty they had to perform was to convince the public that coal smoke was poisonous. "Necessity," said Mr. Cleeves, "knows no law, but necessity excuses some inconveniences." In New York, only anthracite coal might be burnt; yet in London there was no such regulation, though anthracite coal was cheaper in London than in New York. Berlin was, in his opinion, the cleanest city in Europe. As an example of the methods employed, he quoted the case of a factory at Potsdam to which notice was given that it was making too much smoke. The reply was, "We have done everything we can to prevent it." "No, you have not," responded the authorities; "you have not tried anthracite. We give you a month in which to do so." In this case Welsh anthracite, costing much more than it does in London, had to be used. Welsh anthracite can be burnt in ordinary grates. He did it in his own house. If only the public would give it an intelligent and patient trial, he was sure that half the reproach to London would soon be gone.

Mr. Muirhead discussed the procedure in Liverpool. He said that in 1854, before any other city, there was a by-law setting out that furnaces must be constructed or altered so that smoke in unnecessary or excessive quantity should not be emitted. There was a fine of £5 for each day allowed to elapse before alterations were made. The authorities had power also to insist on alterations to chimneys if it was thought to be necessary. The actions were all held before stipendiaries.

Dr. Ormanby suggested that before consolidating the law it would be well to consolidate all the societies which had been formed for the purpose of smoke abatement, so that they might work in unison. He suggested a central association in London, and an affiliation with all provincial societies. Sir John Ure Primrose's proposal could, he said, be carried out by a central body, but not piecemeal. The central body should formulate a method of procedure, and each branch should work in accordance with that. He did not think it would be difficult to arrange about analyses. His firm, for example, would be pleased to undertake the analyses necessary for Warrington. He felt sure that others would be equally public spirited. He thought that it was a great mistake that the inspectors were so often appointed by local committees, many members of which were smoke producers. Of course the inspectors reported them, and of course no notice was taken of their reports.

Why not, said Dr. Ormanby, have a body of inspectors like those appointed under the Alkali Act? Or why not even widen the Alkali Act so as to include the smoke nuisance? The Alkali Act was working so well that there was good hope that such a proceeding would be satisfactory.

Mr. S. Davis, of Woolwich, after referring to the difficulties which authorities experienced in proceeding against offenders under the Public Health Act, referred to the statement that factories were not the chief offenders now-a-days. This, he said, might be true in some parts, but it certainly was not in the East End. It frequently was necessary for him to walk up Shooter's Hill. On most Sunday and Monday mornings it was possible to see the Houses of Parliament and other buildings in London. On other days of the week this was impossible. It was clear, therefore, that factories in his district were the worst offenders, and he particularly complained about Woolwich Arsenal, reiterating and adding force to Mr. Chubb's remarks on this point.

Bailie Anderson, of Glasgow, said that they did not want any more law. They could do quite well enough with what they had got. If the sanitary inspectors and public health officers had sufficient power and security of tenure of their positions, a remarkable improvement would soon be witnessed. He did not see why this sort of work should be left to private effort. The authorities ought to do their own work. It was as wrong to pollute the air as it was to pollute streams, and the same methods should be used to prevent it. It would not be difficult to get the analyses done, but they would be useless unless the authorities exercised their power. Beyond everything, said the Bailie, don't have a Royal Commission unless you wish to kill the whole thing. Pile up statistics. They were most useful, and a health department's chief weapon. It was just as important to keep records of the air as of sewage, water, and other things.

This concluded the discussion, and then the following resolution was proposed by Sir John Ure Primrose and seconded by Mr. Corbett:—

"It is desirable to consolidate the various societies and bodies throughout the United Kingdom, having for their object the diminution of smoke, and that the Coal Smoke Abatement Society should take steps to bring this about."

This was carried unanimously, and the proceedings brought to a close with a vote of thanks to Sir William Richmond.

In the afternoons of Wednesday, Thursday, and Friday, the 13th, 14th, and 15th inst., the members visited the Chelsea generating station of the Underground Electric Railways, the works of the South Metropolitan Gas Company, and the Abbey Mills pumping station at the sewage outfall works.

MOTOR CAR PROGRESS IN FRANCE.

(By our Special Correspondent.)

No. II.*

THE dislike which French makers have of anything that may seem like complication is one of the reasons why so many of them adhere to the standard type of mechanism in all its simplicity. They appear now to have got the most they can out of this system of propelling gear, and it is not easy to see what more they can do without adding fresh mechanical devices for the sake of reaching as near perfection as possible. An instance of this is seen in the various apparatus for automatically starting the engine. Some of these are cumbrous and inelegant devices, which are only fitted to cars as a demonstration and as a means of learning how they will be received by the public. The self-starter will undoubtedly be a necessary equipment when it has been simplified and rendered capable of easily starting the engine cold, and while certain of the apparatus can be relied upon to do this there is yet much to be done before the application of such systems becomes general. That there is really no reason why manufacturers should place bare simplicity above everything else is seen in the popular success of several cars in the Paris Salon, where ingenious new features appealed to visitors more strongly than the chassis, in which everything that might be regarded as in the slightest degree superfluous was suppressed. It is quite possible to make a car interesting without laying it open to the reproach of complication. We may take as an example the car of Messrs. Cornilleau and St. Beuve. Although the design of every part of the car differs from that of any other vehicle, the departures are based upon sound principles, and they show that there are many ways of improving the running qualities of a car and facilitating its control and accessibility without simply refining the standard design. The four cylinders are in one casting, with inspection plates each side covering the valve stems. The valves are large and the induction valves are given a variable lift by a grooved shaft, which, on being rotated by bevel gear, gives more or less rise to the cams. The ignition gear, like everything else, is entirely closed, the magneto contact-breaker being in the form of a steel segment fitting easily around the combustion chamber above the induction valve. By this arrangement the contact-breaker is kept clean by the fresh gas as it is drawn into the cylinder. The engine is started from the seat by a pedal actuating a pawl and ratchet on the countershaft. The keying of loose gear wheels for changes of speed, the spring drive on the differential, and other features of the Cornilleau and St. Beuve car present nothing new, except in the way in which old devices have been improved upon, but they nevertheless show that it is by no means necessary to adhere rigidly to standard patterns in order to secure the approval of the buying public.

The number of firms who are bold enough to introduce features that are not recognised by custom is very small indeed. Even those who have always preserved a certain originality are coming back to the classic form of chassis. The finely finished Buire car is a characteristic example of the way in which everything has been simplified. Here, as elsewhere, the chassis is of such apparently light construction that the cutting down of weight would seem to have been carried to excess. The levers, gear, striking rods, and other parts are small and light, and yet it is certain that this has only been accomplished by dint of improved design and the selection of the most suitable material for particular parts, since these cars have been uniformly successful in the different severe tests in which they have competed. It is clear, moreover that the practice of testing cars on mountain roads, as is done by the Chantiers de la Buire, Berliet, and other makers in the Lyons district, is conducive to lightness of construction and high efficiency, that is to say, the two qualities most sought after in motor cars. When tested for speed on such roads the total deadweight must obviously be as low as possible, at the same time that ample resistance must be given to the various parts. The conditions under which cars are tested have an appreciable effect in modifying design, and the construction of vehicles is therefore more or less influenced by environment. It is partly on account of the valuable lessons provided by tests on mountain roads that the French have lately been in the habit of organising their touring trials in the Pyrenees, the Alps, and other mountainous districts. As a contrast to this practice of cutting down weight wherever possible and producing very handsome and rather costly cars, we see such makers as Gillet-Forest, Delahaye, and others who have had an exceptionally long experience in motor car construction in all its branches, paying less attention, perhaps, to lightness than to durability. There is nothing yet to show that a vehicle of light construction turned out by such an experienced engineering firm as the Chantiers de la Buire will not last as long as a heavier car. It is certainly more costly to manufacture, and in moderately-priced vehicles makers are obliged to build upon more robust lines. A typical example of this type is the Gillet-Forest, in which the large square crank case is fitted with inspection plates to render everything easily accessible. There are three sliding gears, giving four speeds and reverse, and the propeller shaft is carried in a sleeve extending from the differential-box. All the details have been carefully worked out. The valves are given a variable lift by cams, which are always in contact with the stems, the clutch spring is taken up to prevent any undue thrust on the engine shaft, and there are many other little features of an essentially practical type which aim at minimising the strains and vibrations on different parts, and increasing the efficient running of the vehicle.

While it will be seen that progress in the construction of the general type of touring car is limited to small points of detail many firms are giving special attention to the town vehicle, in which they are seeking to modify the chassis. A year ago there was a tendency to avoid the use of long frames by fitting the engine under the driver's seat, but it does not seem as if this practice is likely to be extended. It is doubtful whether there is much to be done in the purely town type of carriage, since the buyer usually prefers to have a chassis that he can employ for every purpose by changing the coachwork as required. Among the few types of purely town chassis in the Salon was an elegant little vehicle exhibited by Charron, Girardot, and Voight. This has a 14 horse-power engine with all the cylinders cast in one piece. All the valves are actuated by one half-time shaft, which also drives the magneto machine by bevel gear, the magneto being placed on the engine bed transversal to the axis of the motor. The frame is low down, and is suspended from behind by large coach springs. The steering wheel is on the left, thus differing from the usual practice, and the driving levers are in the centre, as in the Lanchester cars. The C.G.V. firm have revived the three-point suspension for engine and trans-

* No. I. appeared December 22nd.

mission gear, which seemed likely to have such a vogue a couple of years ago; but the majority of makers dropped this system when they found that the three-point suspension did not provide for the diagonal stresses which are constantly being set up in the frame.

While the touring and town chassis seem again to be merging into one type, it is curious to see that manufacturers are once more paying attention to the high-powered speed car, of which there were several examples at the Salon. Some of them, like the Dufour, of Geneva, are weird-looking machines, with a huge engine of about 160 horse-power, on a light pressed steel frame, wicker seats, and driving levers about the size of those employed on voiturettes. The Cottereau 160 horse-power six-cylinder racing machine is of a much more practical type, and it has a novel clutch which we shall describe when we come to deal with the details of car construction. These big machines are being built in view of the race which the French Automobile Club has decided upon organising in 1906, probably on a circuit around Fontainebleau. The club decided a year ago to suppress racing altogether and replace it with touring car competitions and a race for tires, but as these alternatives do not seem likely to be a success, and the tire race may be dropped through the disinclination of makers to enter for such a contest, the trade has come to the conclusion that the interests of the industry can be best served by organising a big annual race. This is not done with the idea that there is much to be learned from racing, but simply because it has so far proved to be the best means of advertising the automobile industry.

Another development of the trade, as evidenced by the exhibits at the Salon, is the revival of the voiturette. This is the immediate outcome of the heavy production of big cars, which has now so far reached the limit of expansion, that further advance can only proceed slowly, and as new makers are constantly coming into the industry they have no alternative but to look after the requirements of the general public, who are capable of taking an unlimited number of vehicles, if only satisfactory cars are supplied at a low enough price. Until recently manufacturers have confined themselves to building small cars to standard patterns. Seeing, however, that it is scarcely possible further to simplify these patterns, and that the voiturette is built up of almost as many parts as the bigger vehicles, the cost of production is proportionately the same, so that it is quite impossible to sell the ordinary type of voiturette at a price which will make it really popular. Several makers are therefore endeavouring to strike out on new lines, apparently with a good deal of success. As illustrating one type of voiturette, the firm of Sizaire and Naudin have set to work to suppress every part of the mechanism that is not absolutely needed on a small and cheap car. They have simply a single-cylinder horizontal engine with clutch, propeller shaft, and two-speed gear on the differential. A further reduction in cost of manufacture has been effected by Turkheimer, of Milan, who have a 4 horse-power engine cooled by a fan set in the tank in front, with central drive by chain to the countershaft and to the rear wheels by triangular belts. It is difficult to imagine anything simpler than this application of motor cycle design to the voiturette. Another device employed by the Société des Voitures Populaires is to take the drive from a two-speed gear hinging on the crank shaft of the single-cylinder engine to twin pulleys, replacing the differential on the rear axle by a long central belt. As the gear-box swings on the crank shaft, it has a tendency to pull on the belt and give increased adhesion as the speed of the engine augments. These illustrations show that continental makers are seriously tackling the problem of the voiturette, which is likely to become one of the most interesting developments of the automobile industry in the early future.

SIX-COUPLED EXPRESS ENGINE.

THE six-wheeled coupled bogie express engine, a two-page drawing of which we publish this week, is one of ten recently constructed for the Glasgow and South-Western Railway Company, by the North British Locomotive Company, Glasgow. The engines have been specially designed by Mr. James Manson, the locomotive superintendent of the company, to cope with the heavy and fast service between Glasgow and Carlisle, in connection with the Midland Company's service to and from St. Pancras.

From the drawing it will be seen that the cylinders are placed outside the frames, with the slide valves on the top. The valves are fitted with a relief ring or piston, and are actuated by a rocking shaft, the lower arm of which is coupled to the intermediate valve rod by a small die block. The whole of the valve gear has ample wearing surfaces, and works with great ease and absence of vibration.

In accordance with the standard practice of the Glasgow and South-Western Railway, the reversing of these engines is effected by steam and water cataract cylinders, which renders manual labour unnecessary, the whole operation being under control by the movement of one small lever.

The main frames, which are deep and well stayed, are jointed just forward of the leading hornblocks, in order to obviate the necessity of "setting" them at the front end to clear the bogie wheels. The construction of the bogie is clearly shown in our engraving, from which it will be observed that lateral movement is provided for by a swing link arrangement, which gives the engine great flexibility.

The boiler has a fire-box shell of the Belpaire type. The barrel is parallel throughout, the circumferential seams being made with outside butt straps in the shape of weldless steel rings. The tubes are of brass, 2in. external diameter; the inner fire-box is of copper, and is stayed with Stone's bronze stays.

From the details of the tender, which will be given in our next issue, it will be seen that it is carried on two four-wheeled bogies, and that the axle bearings, which are outside the wheels, have independent springs above each axle-box. The tank has a capacity for 4100 gallons of water, and the tender carries four tons of coal.

The engine and tender fittings include the Automatic Vacuum Brake Company's standard apparatus, Gresham and Craven's re-starting injectors and steam sanding gear, metallic packing for piston-rods and valve spindles, sight feed cylinder lubricators, asbestos-packed water glass gauges and protectors, apparatus for carriage heating, &c.

In practical work these engines have given splendid results, proving equal in every way to the work they were designed to do, and have shown that a six-coupled engine with wheels 6ft. 6in. diameter can be successfully enployed on first-class express work. They quickly develop a high speed, and on an easy part of the road a speed of 70 miles an hour is reached and maintained for a stretch of 40 miles, and, judging from the experience of the past two years, they do not seem to be more severe on the permanent way or on themselves than the four-coupled engines. As evidence of this, it may be interesting to mention that several of these engines have run over 80,000 miles without ever having their big end brasses stripped.

The distance between Glasgow and Carlisle is 115¼ miles, and some of the express trains are booked to do this at a net average speed of 51 miles per hour. The load behind the tender over the Barrhead line, where there is a bank of 4½ miles mostly of 1 in 70, is 245 tons, or a gross load of 362 tons. The leading particulars of the engine just described are as follows:—

Cylinders—		
Diameter		20in.
Stroke		26in.
Coupled wheels, diameter		6ft. 6in.
Bogie		3ft. 3in.
Heating surface—		
Fire-box		181 sq. ft.
Tubes		1721 sq. ft.
Total		1852 sq. ft.
Grate area		25 sq. ft.
Working pressure in pounds per square inch		180
Weight in working order—	Tons.	Cwts.
On bogie	17	5
On leading wheels	15	4
On driving ,,	18	1
On trailing ,,	16	12
Total	67	2
Total weight of engine and tender in working order	117	8

In our next issue we propose to give, as a supplement, a four-page wood engraving of this engine, together with some particulars as to the work it does. We believe that this engraving will be the largest woodcut of this class which has ever been published.

GUNBOATS FOR BRAZIL.

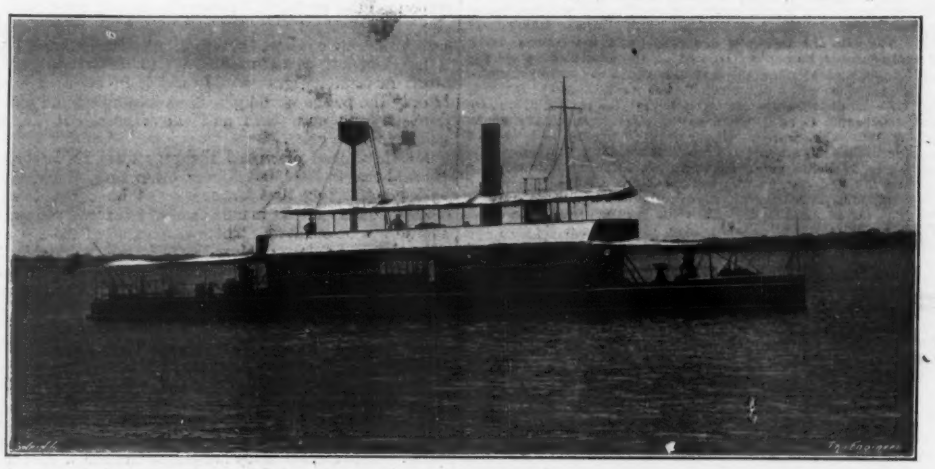
RECENT advices from Para to Messrs. Yarrow and Co., of Poplar, announce the successful completion of the four shallow-draught twin-screw gunboats lately built by them for the Brazilian Government for service on the Amazon. These vessels were laid down in the spring of last year; two were delivered early in September, and the remaining two in November. The dimensions are as follows:—Length, 120ft.; beam, 20ft.; depth, 4ft. 9in. With a load of 25 tons they draw 25in., and have a speed of 12½ statute miles an hour. They are fitted with Yarrow's patented hinged flap, already described in our columns, by means of which it is claimed that one mile an hour additional speed is obtained, without additional power or additional cost. Two deck auxiliary machinery includes steam steering engine, distilling apparatus, circulating engine, electric light plant, fans, and pumps. These vessels were shipped in pieces, and were riveted up and launched on the banks of the Amazon, a party of engineers having been engaged by the Brazilian Government from the contractors' works for the purpose.

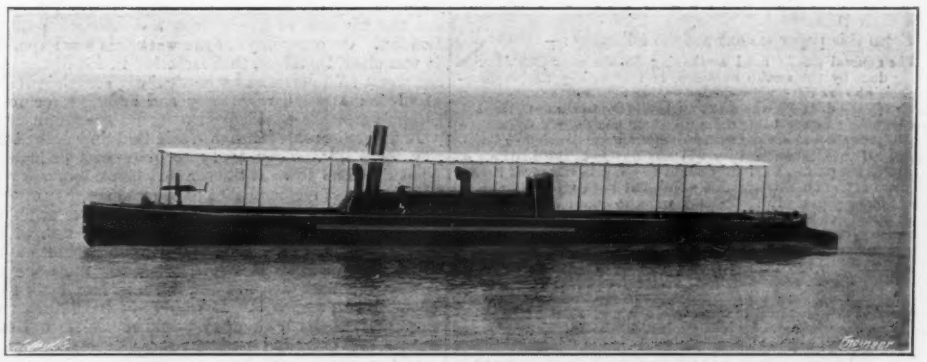
Three smaller single-screw gunboats, which we also illustrate, were also supplied by the same firm. Their dimensions were:—Length, 75ft.; beam, 9ft. 3in.; depth, 4ft. They were also constructed on Messrs. Yarrow's tunnel system, with patented adjustable flap. As will be seen above, the machinery space is completely enclosed. The boats are fitted with two rudders, and can be steered either from forward or from a sheltered position aft of the machinery space. A wooden awning is provided, extending from end to end, and there is a short deck forward, on which, it will be seen, there is a small gun.

This type of launch is now attracting considerable attention, because of its suitability for expeditionary work, its characteristic features being the extreme simplicity of the machinery, the engine being non-condensing, and the boiler of the locomotive type, which is proportioned for burning wood. The draught of these launches, with steam up, is 14in., and on this draught a speed of 10 statute miles an hour is easily maintained. As a rule, these launches are shipped entire from London, and are considered to be just what is required to keep natives under control on some of the rivers, which pass through more or less unexplored districts.

GUNBOAT FOR THE BRAZILIAN GOVERNMENT

YARROW AND CO., LIMITED, POPLAR, ENGINEERS



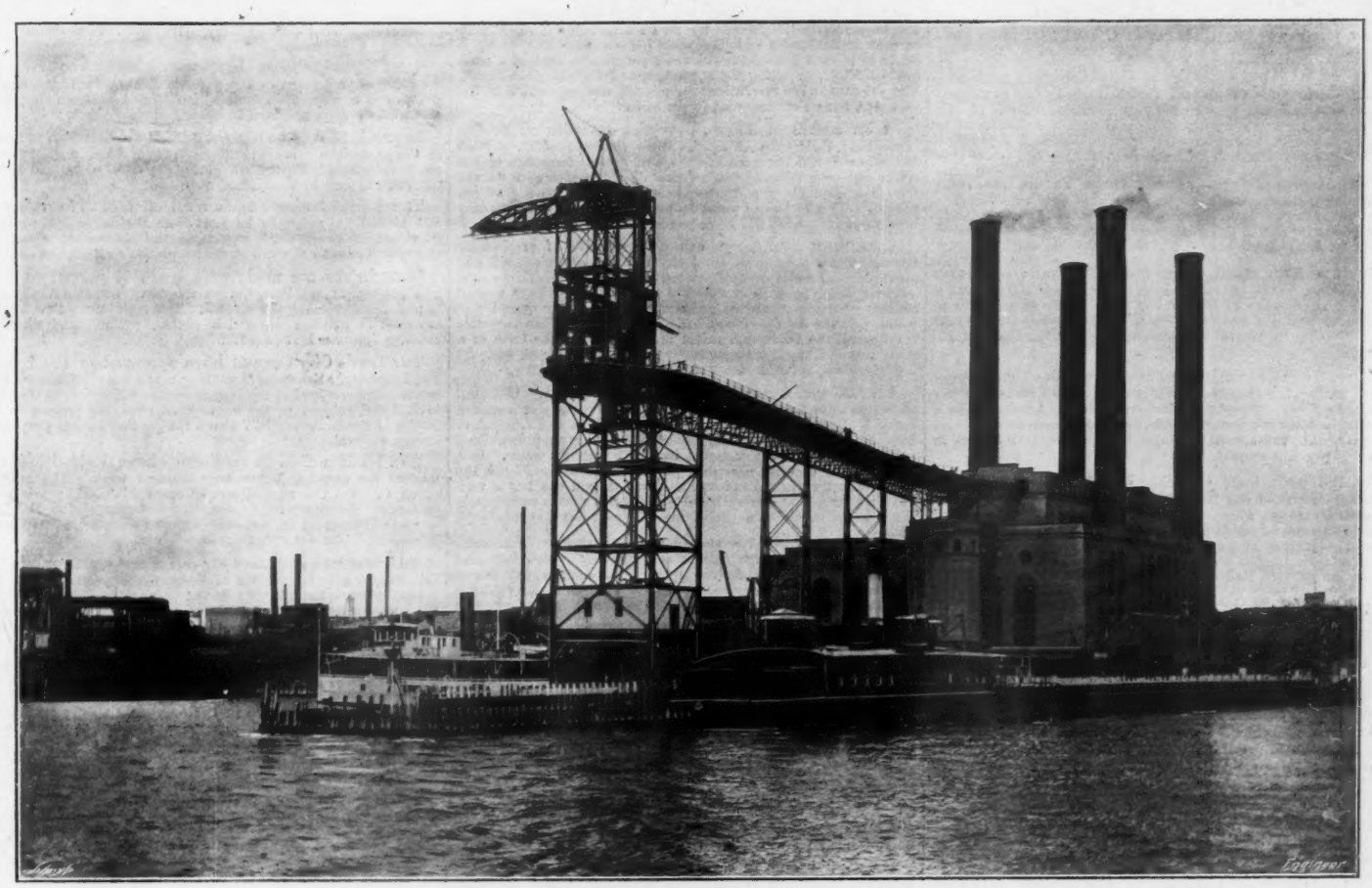


SHALLOW DRAUGHT SINGLE-SCREW GUNBOAT

THE Waterworks Committee of the Wolverhampton Town Council have resolved on an extension of the waterworks undertaking to provide an adequate supply of water for the surrounding district. A large trial borehole at Tettenhall, carried out on the advice of Professor Binnie, has yielded from one to one and a-half million gallons per day, and a second borehole is to be sunk. The scheme involves a cost of £90,000. This sum includes £6545 for a triple-expansion engine, with borehole and ram pumps, £14,500 for a supplemental reservoir, £20,000 for a 24in. pumping main, two miles long, £8500 for two new trunk mains into the town, and £4000 for new sidings and ropeway walks. According to the Engineering Supplement of the *Times*, it is proposed to apply to the Local Government Board for powers to borrow the money on Corporation stock under a provisional order.

LONG ISLAND RAILWAY—NEW YORK POWER STATION

(*For description see page 634*)



THE CITY POWER STATION

5500-K.W. STEAM TURBO-GENERATORS

RAILWAY MATTERS.

THE Board of Trade have published the amended and confirmed order authorising the construction of a light railway from Hope Station, on the Dore and Chinley line, to Bradwell and Castleton.

THERE is a proposal to join up the Huddersfield and Halifax tramways. The Huddersfield Council have given their approval to the scheme, which is being promoted by the West Yorkshire Tramways Company.

THE Missouri, Kansas, and Texas Railway has arranged to take over in January next the Texas Southern Railway 72-mile line now in receiver's hands. It is said that a branch is to be built to Arkansas Pass, presumably from Smithville, the junction of the San Antonio branch, with the main line.

THE Atchison, Topeka and Sante Fe Railroad, on which line occurred the disastrous wreck of October 30th, has given an order to discontinue the use of old and comparatively weak passenger cars in the front ends of trains, and has ordered 55 new smoking cars to take the place of these old ones.

ON June 30th, 1905, there were 3064 railroad routes in the United States, the total length of which was 200,965 miles, with a train mileage of 362,645,731 miles. The expenditure in the United States was 39,833,070 dols. The increase for the year was 4057 miles in length of routes, and 9,607,334 miles in train mileage.

OWING to the unusually favourable weather which prevailed during the Christmas holidays the traffic returns of the principal railway companies which have access to London show a material increase in passenger traffic over the corresponding period last year. The continental passenger bookings were also much in excess of previous years.

ON the 20th inst. Colonel Druitt, Board of Trade inspector, inspected the Rochdale section of the Heywood Corporation tramways, which couples up virtually the whole of the electric tramways system in Lancashire. It will now be possible to make a journey by tram from Rochdale to Liverpool, and, by the construction of a track in the Todmorden district, through connection between Halifax and Liverpool will be obtained.

LAST week, at York, a Light Railway Commission inquiry was held into an application to transfer the powers of the Derwent Valley Light Railway Order, 1902, from the rural district councils of Escrick and Riccall to a company proposed to be formed with a share capital of £31,000. The original order authorised the construction of a light railway from Cliffe Common Station, near Selby, to York, through 16 miles of agricultural country.

AFTER a contention of more than three years the railroads operating in the State of Illinois will be compelled to reduce their freight rates an average of 20 per cent. on January 1st, according to a decision just rendered by the Illinois State Board of Railroad and Warehouse Commissioners. It is stated in the *Iron Age* that rates on shipments inside the State and outside of the city of Chicago have been from 20 to 50 per cent. higher than shippers in neighbouring States have had to pay the same railroad interests.

THE amended Bill to enable the Corporation of Oxford to work and construct tramways has been sealed. The following figures have been inserted in the Bill:—(*a*) For and in respect of the reconstruction and construction of tramways as authorised by the Act, the sum of £76,228; (*b*) for and in respect of the purposes of electric equipment and other incidental expenses in connection with the tramways, the sum of £39,357; (*c*) for lands authorised to be purchased and buildings to be erected, the sum of £17,250—making altogether £132,835.

FROM the annual return of the capital and traffic of tramways and light railways of the United Kingdom for 1904-5, issued by the Board of Trade, it appears that since the year 1878 the length of lines open for traffic has grown from 269 to 2117 miles, the capital expenditure from £4,207,350 to £52,675,152, the net receipts from £230,956 to £3,351,977, and the number of passengers carried from 146 millions to 2069 millions. Out of a total of 2117 miles of rails, 1780 are electrical. Of 320 undertakings, 174 belong to municipalities.

AN increase of 46 miles in the Government railways system of New Zealand is reported in the statement of the Minister of Railways for the year ended 31st March last, and the system now has a total mileage of 2374 miles. The capital cost of these lines, including the Lake Wakatipu steamers, is £21,701,572. Net revenue last year was £716,331, equal to a return of 3·30 per cent. on the capital. Passengers carried numbered 8,514,112, an increase of 207,729. The system owns 389 locomotives, 864 passenger cars, and 13,885 wagons and brake vans.

THE Bill to require the use of the block system on all the passenger railroads of the United States, which was introduced in Congress a year ago, has been again introduced in the fifty-ninth Congress. The Bill now requires the use of the block system on one-fourth of every railroad by July 1st, 1908; one-half by July 1st, 1909; three-fourths by July 1st, 1910, and the whole of the road by July 1st, 1911. On a road or part of a road having yearly passenger earnings of £300 a mile, or total earnings of £600 a mile, the Commission may shorten the time of introduction by two years.

THE question of liability for fire caused by sparks from a railway locomotive has just been tried in Germany, and decided against the railway company. Last August sparks issuing from a locomotive, drawing a goods train, set fire to the vast forests of Bunzlau and Brukenau, in Prussian Silesia, and the forests were destroyed almost entirely. The owners, who numbered thirty-three, and included the Duke of Schleswig-Holstein and Count Dohna, entered a civil action against the directors of the Prussian Railways for damages, and they have been awarded the sum of £150,000.

BRITISH railways are not alone in suffering severely from tramway competition. In America the inter-urban services are being developed to a wonderful extent. Thus, it is stated that by about the middle of 1906 a continuous electric inter-urban line will be in operation from Chicago to Freeport, a little more than 100 miles through one of the richest and most populous sections of Illinois, and connecting the cities of Freeport, Rockford, Belvidere, and Elgin, besides numerous smaller places of considerable importance. It will run parallel to the Chicago and Dubuque, or old Galena, division of the great Chicago and North-Western system.

A SUCCESSFUL trial on the Paris, Lyons, and Mediterranean Railway was recently made of a new motor vehicle, constructed from the designs of M. Serpollet, which will be introduced in future on those parts of the system where the traffic is light. The trial run was made on the new line from Dijon to Epinacles-Mines, on parts of which there are gradients of 23 per 1000. The motor can attain a maximum speed of 37 miles per hour, and carries 52 passengers, but it is capable of drawing two other coaches, making up the total to 156 passengers, if required. The fuel used is heavy shale oil, and only one litre per train-kilometre, at a cost of 12 centimes—about 1¼d. per train mile—and 12 litres of water are needed for 15 kiloms.

NOTES AND MEMORANDA.

ON her return trip the Cunard turbine steamer Carmania steamed on an average 17½ knots. During the whole voyage she met with persistent head winds. Her best day's steaming was 420 knots.

AT the Montreal Waterworks a high-lift turbine pump has been installed, operated by an electric motor, which uses current at 2200 volts and 63 cycles per second. The pump is designed to raise 3800 gallons of water per minute against a total head of 300ft., requiring the expenditure of 450 net horse-power. The set runs at 740 revolutions per minute, and, according to the *Iron Age*, has an efficiency of 78 per cent.

IN its course of 3000ft. over the cascades above the Horseshoe Falls the Niagara River descends 55ft. With 222,000 cubic feet per second as the total normal discharge of the river, and with 90 per cent. of this discharge going down the Canadian channel, the volume there is 199,800 cubic feet per second. This volume of water falling 55ft. makes available somewhat more than 1,370,000 horse-power on the Canadian side.

ALUMINIUM skimmings are unlike those of any other metal. Brass skimmings are finely divided, and the shot and other pieces of metal are easily sieved out. Aluminium skimmings, however, are of an entirely different nature, and consist of a small amount of oxide of aluminium mixed with a larger quantity of metal, says the *Engineering and Mining Journal*. When a crucible is skimmed, the oxide and metal are removed in the form of a pasty mass. The skimmings consist principally of metal, and the loss in melting is far in excess of that of most other metals.

ACTUAL measurements and experiments by German physicists show that the rate of diminution of velocity of a shot in water is directly proportional to the velocity at the moment of incidence with the water; the rate of loss of energy is proportional to the square of the velocity at incidence with the water. In a second series of tests, described in the *Annalen der Physik*, the depth of water was taken into consideration, and the law is verified that the rate of diminution of velocity of a shot in an infinitely thin layer of water is also proportional to the velocity at incidence.

THE chief rubber-yielding plant occurring in Zululand is a vine, known by the natives as "Ibungu," which has been identified as *Landolphia Kirkii*, Dyer. This plant is well known as one of the most important sources of rubber in East Africa. Samples of the rubber prepared from it in Zululand were forwarded some time ago to the Imperial Institute for analysis and valuation. According to the Bulletin of the Imperial Institute, they were found to be of good quality and were valued at about 4s. per lb. in London, at a time when fine Para was quoted at 4s. 8d. per lb.

THE Natal Government are offering to lease the rights of rubber collection in certain portions of the Ingwavuma district of Zululand for a period of five years, and are inviting tenders from persons interested in the production of rubber. The area to be leased lies to the east of the Pongola River, and has been divided into three sections, which have approximate areas of 110, 150, and 350 square miles respectively. A copy of the conditions upon which the leases will be granted, and a plan showing the limits of the different sections, can be seen at the office of the Agent-General for Natal, 26, Victoria-street, London, S.W.

UP to the end of last century the German cement industry, though its progress was increasing at such an extraordinary rate, was a very profitable one. The average dividends paid by all the larger works in 1899 amounted to 17 per cent. In the following year the average sank to 12 per cent., and at the same time the union of the syndicated groups of German cement works, which had been in existence for some time, collapsed. Since then the manufacture of Portland cement in Germany has been in a very precarious condition, and, in spite of attempts to re-establish the cement trust, nothing has been done.

AMONG the foundrymen who, under the direction of their chemists, have been reducing the pressures in their cupolas from time to time, it is significant that a company in Chicago operating the largest number of cupolas, as well as the largest in size, is the firmest believer in low blast pressures. It is now installing two cupolas of 84in. inside diameter and a centrifugal fan blower to give 24,000 cubic feet of air per minute at 10 oz. to 12 oz. pressure in the wind box of the cupola. The great fluidity of the iron, the quality of the castings produced, together with the capacities and low horse-power per ton of iron melted, certainly seem to prove the claims for low blast pressure.

FOR transmitting 50,000-volt current from the power house at Taylor's Falls to the city of Minneapolis, Minn., a distance of 41 miles, a 60ft. right of way has been purchased. Most of the transmission line will be mounted on poles of Oregon cedar, but in some sections, where an unusually heavy strain may be met, steel towers will be substituted. The copper wire has a diameter of about ⅜in. The porcelain insulators each weigh 22 lb. Three-phase current will be generated at a pressure of 2300 volts, and will be raised to line pressure in step-up transformers. At the sub-station in Minneapolis the pressure will be reduced to 13,000 volts, at which the current will be distributed for use.

A VERY long bridge is being built over the Hoang-Ho, China, for the crossing of the Hankau-Peking Railway. The river is about two miles wide at the crossing, and the bridge will have 102 spans, aggregating about 10,800ft. A recent consular report, which gives some information about the railway, says: "The bridge is not constructed of heavy structural steel, but is of more frail design, which, however, will apparently prove of ample strength for the light locomotives and cars in use on this road." The bridge should be completed within a very short time. The trip between Hankau and Peking—754 miles—is expected to be reduced to thirty-six hours when the bridge is put in service.

THE first of the 16,000-ton United States battleships, Louisiana, went through her standardisation trial on December 13th over the one-knot course in Penobscot Bay, Me. She made, according to unofficial figures, an average of 18·61 knots, or ·61 of a knot more than her contract specifies, on five high-speed runs. The highest speed attained was 18·92 knots. She steamed over the course twelve times, starting at high speed and gradually reducing the number of revolutions of her engines, so as to enable the Naval Trial Board to plot a complete speed curve from which to determine the number of revolutions required to drive the ship at her contract speed of 18 knots. It is estimated that the number of turns necessary to do this is 119. The maximum number of revolutions attained was 125.

COPPER has been successfully deposited on aluminium by Mr. A. Lodyguine, who describes the process as follows:—An anode of pure copper, and an electrolyte of water, with a few drops of sulphuric acid, was used. After the current had been passed for some time, some $CuSO_4$ was formed, and from this copper was deposited. The plate was taken out after 30 minutes, and well washed in water, then in a solution of HCl, next in NaHO solution, and finally in water. The same operation was repeated several times, until the plate was evenly coated with copper. On the coppered plate antimony was deposited from a concentrated solution of Na_2S. Lumps of trisulphide of antimony were placed in a porous pot, with a carbon anode. The cell was filled with the electrolyte. On the coppered aluminium cathodes the antimony adheres firmly, and the deposit can be continued as long as the monosulphide of sodium is not converted into polysulphides. A current density of 0·0013 amperes per square inch, with 1 to 1·5 volts, was found to be satisfactory.

MISCELLANEA.

IT is estimated that the annual consumption of coal in New York is 15,500,000 tons, of which 9,000,000 tons are anthracite and the remainder bituminous coal.

INSTRUCTIONS have been given by the Admiralty for the installation of electric light and power at Sheerness Dockyard, to be taken in hand without delay. The work will be executed by contract.

THE United States battleship Idaho was recently launched at the yards of the William Cramp Ship and Engine Building Company, Philadelphia, Pa. The Idaho is a sister ship of the Mississippi, and is of 13,000 tons displacement.

THERE is said to be a great scarcity in ferro-manganese in the American market; this is causing steel manufacturers much uneasiness. Buyers will gladly pay as much as £26 a ton, but there is none to be obtained at present at any price.

THE Admiralty have made a selection of 277 mechanics and skilled labourers to be sent from the home dockyards to Gibraltar to execute the repairs to the Assistance, which was seriously damaged through stranding on the rocks at Tentan.

CORK bricks are made of a paste of pulverised cork with plaster, cement, lime, magnesia, or tar. The paste is subjected to pressure in rectangular moulds. The cork bricks thus formed are used as building material in arches, roofing, and wherever extreme lightness is required.

THE Leeds City Council have approved of the recommendation of the Sewerage Committee to purchase 1000 acres of land in the neighbourhood of the sewage works at Knostrop at the price of £231,000, subject to the corporation obtaining powers in the session of Parliament of 1907 to use the grounds for the purpose of sewage disposal.

THE Huddersfield Town Council have decided to invite tenders for carrying out sewage disposal work. The scheme, which involves the expenditure of some £135,000, provides for increasing the number of precipitation tanks at the Deighton works, and carrying the sewage forward a mile distant to Cooper Bridge for treatment in bacteriological beds.

THE first "co-operative system of hot water supply" in this country is to be installed at Kells, Whitehaven, in thirty-two miners' cottages built for the Earl of Lonsdale. Hot water for all the houses will be supplied from one boiler, and the arrangement is expected to prove economical and convenient. The ordinary Cumberland cottage has not a hot water boiler.

A NEW Swedish industry, the manufacture of Dinas bricks, has been started, it having been found that with the quartzite in Dalsland it is possible to make excellent bricks. Works were built at Köpmannabro in 1902, and in 1903 the output was 100,000 bricks, in 1904 it was 160,000, and in 1905 it will probably be 300,000. The bricks are 10 to 20 per cent. cheaper than imported firebricks.

THE turbine steamer Viper, now being built at Fairfield for Messrs G. and J. Burns, is expected to attain a speed of over 21 knots, and will thus be the fastest steamer sailing on the Clyde or to and from Belfast. Her engines are expected to indicate 6500 horse-power, and her accommodation will be of the most sumptuous character, and far ahead of anything hitherto provided in the Irish cross-Channel services.

THE Commissioner of Salt Revenue, Bombay, suggested the opening of new sea salt works as the best means of permanently increasing the supply of sea salt in that Presidency, and the suggestion has been accepted by the Government of India. A scheme has been formulated accordingly for the construction of such works on the foreshore of the Thana Creek between Thana and Bhandup, and will doubtless be sanctioned and carried out.

AT present the Transvaal is producing every month gold to the value of about £1,700,000, and the dividends declared this year exceed 7½ millions. The producing mines of the Rand are crushing about 1,000,000 tons of ore per month, with a milling power of about 7000 stamps. It has been predicted that within the next decade 15,000 stamps, or their equivalent in tube mills or grinding pans, will be at work. About sixty tube mills are at work.

A CONSIDERABLE improvement has been introduced during the last few years by the substitution of a naturally occurring fibre—ramie—for cotton in the manufacture of mantles for gas lighting. This gives considerably more ash on burning than most cottons, and mantles made from it contract less in "burning-off" and are stronger than those made from cotton. Ramie, moreover, absorbs less of the rare earth mixture than does ordinary cotton.

THE question of introducing gas plant in place of steam into the jute mills of Dundee has been discussed. In view of the proposed large developments in connection with the Corporation Electric Station, there is a probability that one or more of the mills will substitute electric power for steam. A suggestion has been made that several manufacturers should combine and erect a Mond gas producer with a recovery plant for ammonium sulphate, each mill having its own gas engines.

THE parliamentary majority now seems to favour the proposition to adjourn the question of cutting a new bed for the river Scheldt at Antwerp, and to proceed with the immediate construction of a five-mile canal, with open docks, according to the Brussels correspondent of the *Daily Telegraph*. It is believed also that the military authorities will agree to the immediate demolition of the existing line of fortifications, which now absolutely prevents all territorial expansion of the city or dock area.

IN support of his recommendation of an appropriation of £10,000 for engineer equipment of troops, the Chief of Engineers, U.S.A., makes the interesting statement that much of the pontoon bridge equipment now available dates back to the Civil War. The amount is limited and is sufficient only for the routine pontoon drill of the present authorised force of engineer troops. In view of these conditions, it is intended, in case the appropriation of £10,000 be voted, to expend half of the full amount on additional pontoon equipment.

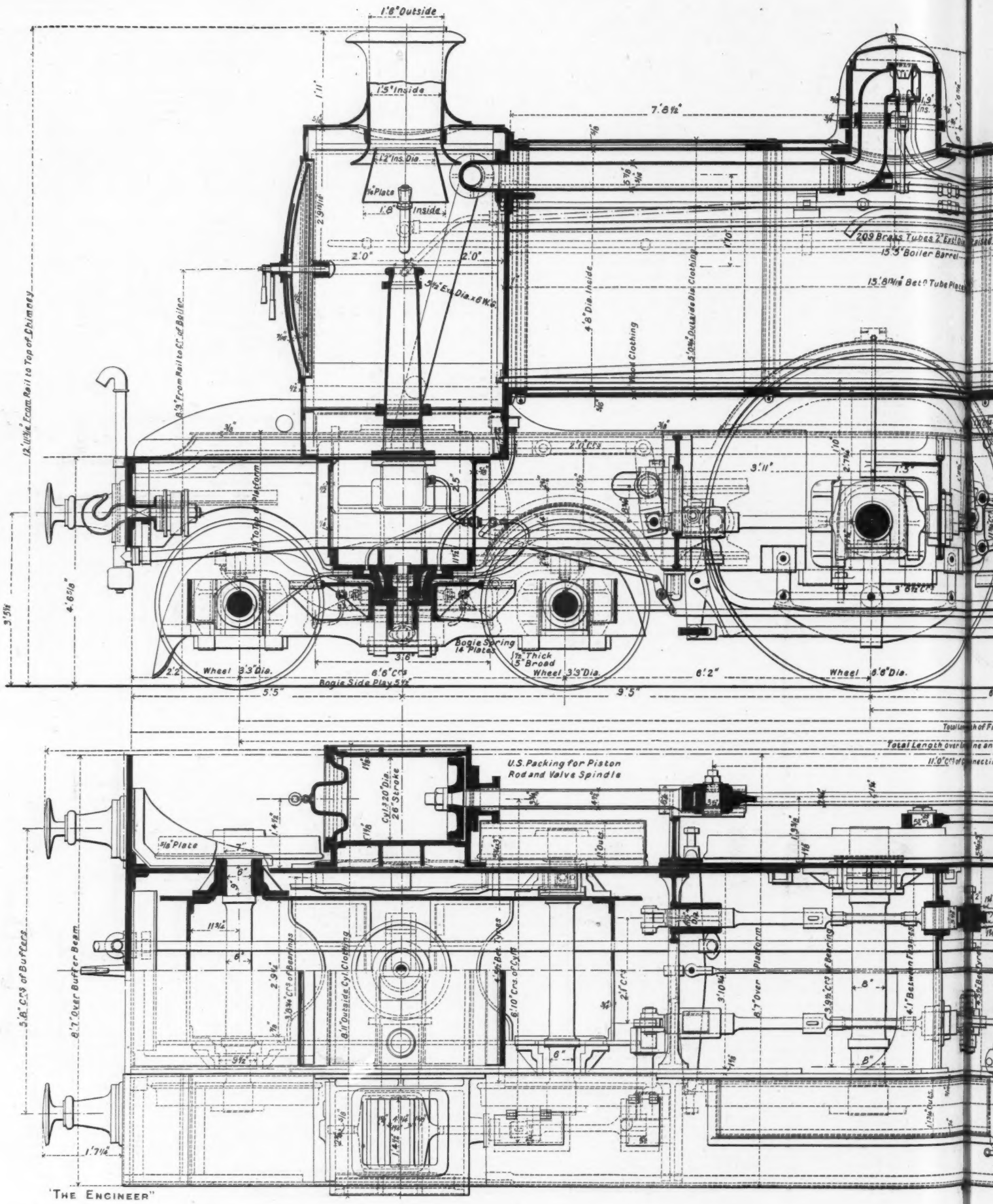
THE water famine at Leicester daily becomes more critical, and it is feared that the supplies will have to be further curtailed, although they are now cut off ten hours out of twenty-four. About 300,000 gallons of water per day are obtained from a colliery shaft, and so great is the emergency that 200,000 gallons per day are being pumped from a well which has been sunk in a field adjoining a cemetery within the borough. The cemetery is at Belgrave, and while dead bodies are being buried, says the *Times*, an engine is pumping water from a well within a few yards direct into the mains.

IN using incandescent mantles for gas lighting, it is generally found that the illumination increases for a certain period, and that then a steady fall sets in. The initial steady rise is probably due to the gradual shaping of the mantle to the flame. The subsequent fall has been shown to be occasioned by two causes. Dust particles of silica are carried by the draught against the mantle, where they form, with the oxides, infusible silicates having a small emissive power. A more potent cause is the gradual volatilisation of the ceria, to which the whole of the incandescence is due. It has been shown, too, that the hygroscopic state of the atmosphere has a small though perceptible influence on the luminosity of a mantle.

SIX-COUPLED EXPRESS LOCOMOTIVE, G

MR. JAMES MANSON, KILMARNOC, LO

(For descripti... pag...

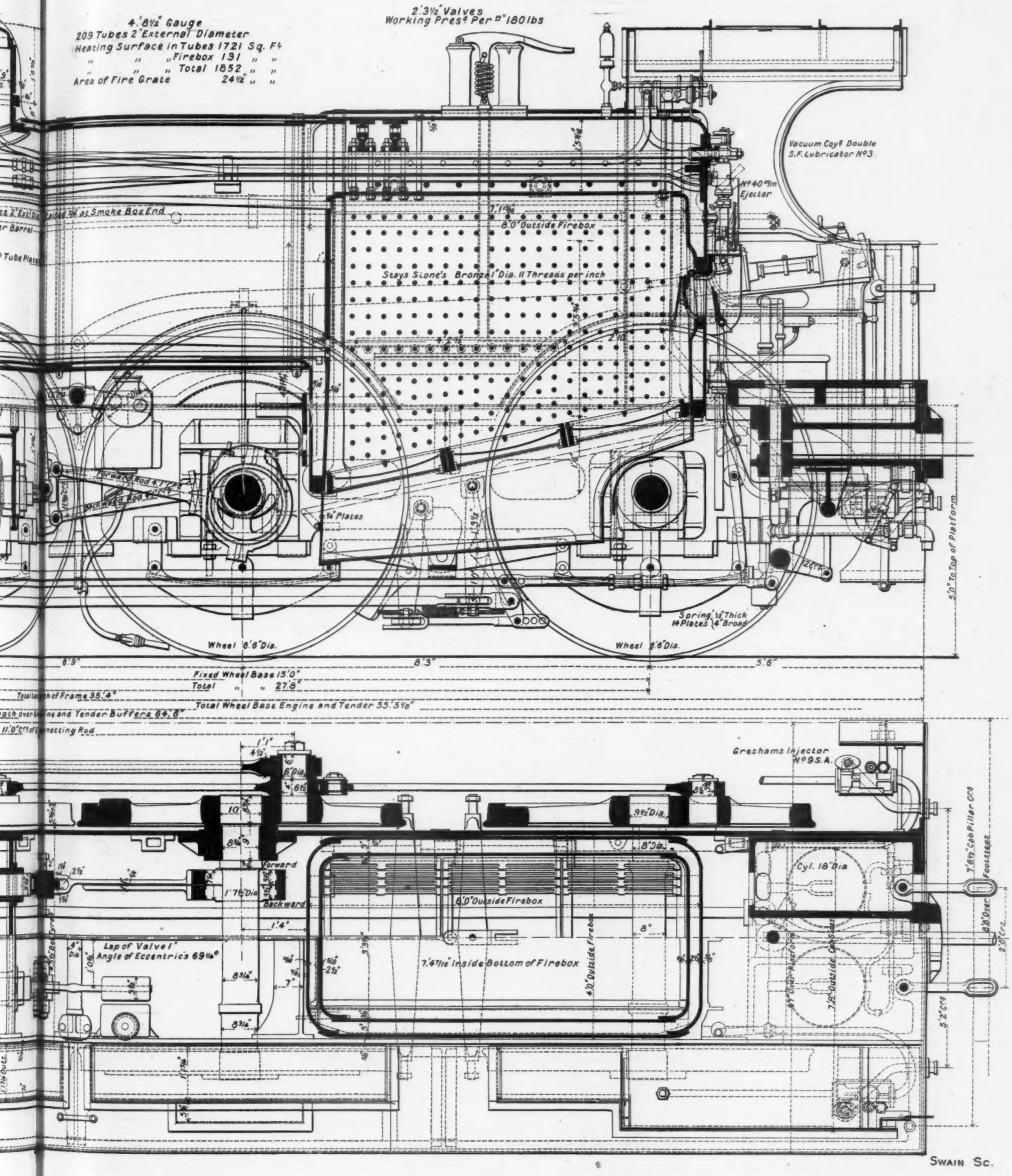


"THE ENGINEER"

E, GLASGOW AND SOUTH-WESTERN RAILWAY

LMARNOCK LOCOMOTIVE SUPERINTENDENT

(For description see page 638)


4'-8½" Gauge
209 Tubes 2" External Diameter
Heating Surface in Tubes 1721 Sq. Ft
" " " Firebox 131 " "
" " " Total 1852 " "
Area of Fire Grate 24½ " "
2'-3½" Valves
Working Pressure Per Sq. In 180 lbs
Vacuum Co.y's Double S.F. Lubricator No 3.
No 40 Ejector
8'-0" Outside Firebox
Stays Stone's Bronze 1" Dia. 11 Threads per inch
Spring ½" Thick 14 Plates 4" Broad
Wheel 6'-6" Dia.
Wheel 6'-6" Dia.
8'-3"
8'-3"
5'-6"
Fixed Wheel Base 15'-0"
Total " " 27'-6"
Total Wheel Base Engine and Tender 55'-5½"
Greshams Injector No 9 S.A.
Cyl. 18" Dia
6'-0" Outside Firebox
7'-4 7/16" Inside Bottom of Firebox
Lap of Valve 1"
Angle of Eccentrics 69½°
Forward
Backward
Swain Sc.

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TO CORRESPONDENTS.

☞ *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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☞ *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

H. T. (Colombo).—Your letter has been forwarded as requested.

W. R.—There is so far, we believe, no official report of the Mining and Metallurgy Section at St. Louis Exhibition.

ALPHA.—We should say that the saving to be realised by compounding with such a low pressure would not be commensurate with the cost of the necessary alterations.

P. W. G.—Correspondents are requested to give their full names and addresses. We are unable to refer you to any single book on the subject of machine shop methods. The best information is scattered through the pages of the technical Press. There are many books on tools. Possibly two by Mr. Shaw, published by the Scientific Publishing Company, Manchester, are as good as any.

THE ENGINEER.

DECEMBER 29, 1905.

THE APPRENTICESHIP QUESTION.

IN France, no less than in this country, the problem of the apprentice is beginning to clamour for attention. In 1902 an inquiry was held by the Conseil Supérieur du Travail, and it was reported that apprenticeship in France was declining to an alarming extent, both as regards numbers and efficiency. Matters have improved but little since then. There is no lack of young people working in the factories, there are more than enough, but they are not apprentices, they are not taught the trade, but are engaged on work on which it is profitable to employ them, and they are paid wages in the ordinary sense of the word. The resemblance to the condition of affairs which prevails here is obvious, and, indeed, under modern methods of manufacturing the condition is, unless by-laws and regulations intervene, inevitable. Keen competition and close cut prices, the automatic tool, the jig and the rig, the tool room, the routine card, the single operation method, and the hundred branches of the organisation of a well-ordered and profitable factory, have made it possible for a great part of the work to be carried on by intelligence trained within the narrowest bounds, and, since such labour is highly economical, it is very largely employed. Moreover, the opposition to the system which might have come from the parents and guardians of the lads has not only been removed, but has been actually replaced by encouragement. Actuated by the desire—frequently from necessity—to see the children contributing to the support of the home, the parents, rather than bind them apprentice, have sought employment for them at remunerative wages. The result is unavoidable; the employers require lads to do routine work, the parents wish their boys to earn wages; the apprentice disappears, and his place is taken by a youthful workman.

In a careful essay on the subject by M. Alfassa, which appears in the current issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, France is invited to consider "what will become of her industry at a not far distant date, when the reserve of young workpeople, having finished their apprenticeship, shall have been entirely absorbed by the needs of the profession?" It is culpable negligence, we are told, not to look into the problem at once, and at the cost of some sacrifices attempt to solve it, because if we delay till the last moment it will be fruitless then to throw open our works freely to all who desire to learn. The harm will have been already done. M. Alfassa then proceeds to review the progress that has been made in France towards a solution of the difficulty. It has been considered by several influential bodies, and reports have been drawn up by various persons on the methods adopted in foreign countries—with the exception of Great Britain, which presumably is itself in too parlous a state to be a profitable study. The outcome of all the considerations appears to be that compulsory technical education for every lad or girl employed in a trade must be established. The term "apprentice" is used, but there seems little doubt that the reporters have in mind all young people between twelve and eighteen years of age engaged in factories. Indeed, the Conseil Supérieur du Travail has drawn up a long document which is the first step towards a new law which will apply to boys and girls, whether they are bound by written indentures or not. This law is to provide, where necessary, for the establishment of technical or trade classes, attendance at which, during eight hours per week, will be compulsory. The employer will be obliged not only to permit attendance at these classes within the legal ten-hour working day, but he will be expected to see that his young people are regular and proficient in their studies. At the end of each year there will be an examination in proficiency, and every lad or girl who can pass it will be exempt from any further attendance at the classes. Presumably, this examination is constant; that is to say, it is not designed to show the progress made during any one year, but to indicate the standard of knowledge and intelligence that has been reached. Furthermore, any youth who fails, after a year of steady application, to satisfy his teachers that he has the mental capacity for greater improvement is to be exempt from further attendance. In the examining body will be included representatives of the employers. The education is to be entirely free, and the cost is to be borne by the municipalities aided by State subventions. It is needless to add that those who have received technical education at other schools will not be called upon to attend these classes.

These proposals are to be discussed in a short time, and in all probability they, or others closely resembling them, will become law. A point well worth observing is that the scheme is not for technical education in the general acceptance of the word. It is not intended, as we understand the proposals, to make the workman higher than his station—the object of many schemes—but to make him better fitted for it by giving him the instruction and information which the apprentice used to obtain in times past from his master. It is to be supposed that, had the apprenticeship system not failed, the present propositions would never have been made. It is the general opinion of employers that a higher standard of intelligence is required rather than a deeper technical knowledge amongst their workpeople. Such intelligence was encouraged and developed by apprenticeship, but has sadly departed in these days, when a youth rises from one automatic or semi-automatic machine to another, when the various processes that have to be performed are defined precisely for him, when the general drawing is replaced by the single detail sketch, and when only very few men out of the complement of a works are required to be able to read a drawing at all. Men so trained lose both the faculty of expressing any ideas that may be in them, and the power of understanding the ideas of others. Intelligence of this kind may be regained by a simple education, and the whole tendency of the scheme under consideration appears to be to give that education and that only. That it proposes to go no further is obvious from the fact that as soon as the standard is reached attendance at the classes ceases. There is, therefore, much in the proposals to commend them. On one point there is likely to be differences of opinion. It is on the question of payment for the classes. We venture to think that the example set, amongst others, by the London and South-Western Railway Company under Mr. Drummond, which includes all the better parts of the scheme, has the further advantage that the classes are paid for by the company—that is, by those who are to profit by the result. We ask if it would not be possible to make it obligatory on every manufacturer who employs, say, a minimum of ten lads or girls to provide suitable classes for them—like the schools in some of our theatres—and to insist on those who, employing a fewer number, send them to outside classes, to pay a subsidy to the school at which they attend? Such education is, we submit, not a burden which can be fairly laid upon the general ratepayer.

CANALS.

WE read with pleasure that Sir Henry Campbell-Bannerman includes in his political programme the appointment of a Commission to investigate the canal question. It will be the latest of many inquiries, if not the last. Its prospective value lies in the possibility that it will once and for all give the answer to a problem which has perplexed a great many people for years. On the terms of reference, however, much depends. The Commission may have much or little to decide, according to the number and nature of the questions which they will be called upon to answer. But the prominent question ought to be exceedingly simple in its nature. Can canals of any kind be worked at a profit in this country? If they are not so worked, then the loss must be made up by some persons who do not use the canals. This is a very important truth, which must not be permitted to drop out of sight. A canal may be managed by an individual, a company, or the State. If those who use it do not pay a sufficient sum for working it and maintaining it, then the individual, or the company, or the State must pay the difference. We

have here a serious menace for the taxpayer. It is well known that the canals which are worked in this country pay very small profits. As they are presumably the most important water lines that it is possible to construct, it may be assumed that new waterways must constitute an exceedingly risky speculation. We shall hear it argued that they are to be worked for the general good. But this is a phrase of extremely unpleasant significance for those who pay rates and taxes.

Reviewing the situation, we find that there are something over 3000 miles of canals in the United Kingdom, of this mileage a small proportion is represented by large waterways, such as the Aire and Calder, the Weaver Navigation, the Crinan Canal, the Gloucester and Berkeley, and one or two others of less importance. In 1791 to 1794 there was a mania for constructing canals, but leaving out ship canals, none have been made in this country since 1834. The greater part of the canal system is only 3½ft. to 5ft. deep, with locks 72ft. by 7ft., with 4ft. on the sills; the largest locks are found, with a very few exceptions, on the Aire and Calder; they are about 220ft. by 22ft., with 9ft. on the sill. The normal small canal has a multitude of defects so considerable that it is admitted on all sides that the existing canal system is entirely inadequate to satisfy the programme of those who see in waterways the solution of the cheap transit problem. Calling spades spades, this simply means that the canal cannot compete with the railway. Structural improvements are, therefore, necessary in existing canals, while new canals must be constructed. Furthermore, it is admitted that horse traction is quite inadequate, and that mechanical traction must take its place. The first structural improvement contemplated is the enlargement of locks which will permit the use of bigger barges. This latter point is doubtful. The second improvement is the substitution of mechanical power for horses. Mechanical canal haulage has attracted inventors for a great many years, and very large sums have been spent in attempts to solve it. Many years ago Messrs. John Fowler and Co. tried traction engines to haul canal boats, the engines working on the towing path. According to another scheme, rails are laid on the path and a little locomotive, steam or electric, does the towing. The chain towage system in use on the Seine is well known, no doubt, to many of our readers. The chain lies on the bottom of the river. It is anchored at each end, and passes over sprocket wheels in the steam tugs which haul long trains of barges behind them. Steam screw tugs are in regular use in the Midlands. The paramount objection to all such schemes is great first cost and a wholly inadequate return. In order that a canal may carry anything usefully, save coal and iron, and bricks and stones, and such like, the speed of the boats must be greater than 2½ miles an hour. But an increase in speed enormously augments the cost of maintenance because of the wear and tear of the canal banks. The normal narrow canal cannot endure speeds of more than three miles an hour. As soon as that is exceeded various precautions must be taken to prevent the washing in of the canal banks. It is, of course, possible to make the banks quite safe; but the works cannot be properly done without the expenditure of large sums. There are canals in this country and abroad which now carry much heavy traffic, but these are comparatively broad waterways, and cost a great deal of money. If the canals of Great Britain are to compete with the railways in transporting goods as well as minerals, then they will have with very few exceptions, to be nearly remodelled. Whether the remodelling will prove of so much advantage to the country that it will be worth while to spend the money, it is for the Commission to ascertain. It is worth notice in this connection that the railway companies have for some time past been accelerating their goods service. The North-Eastern Company, for example, is running certain goods trains at express passenger speed, and with doubled roads and more powerful locomotives there is really no reason why that should not be done for large quantities of merchandise which has for many years been done for fish and fruit trains.

In order that Sir Henry Campbell-Bannerman's proposals may be properly considered, it is essential that we should understand what is the theory on which the proposed Commission is to be appointed. So far as can be seen, the idea is that the railways of the country do not carry goods at as low a price as they might; and that, on the one hand, the presence of canals would improve traffic facilities and reduce the cost of transport, while, on the other, the canals would very greatly augment the carrying power of the country. Now, seeing that the work done by the canals in existence is but as a drop in the ocean compared with that of the railways; and that these canals cannot without a considerable outlay be rendered competent to deal with any large development of traffic, it follows that the Commission will find itself compelled to say whether or not the construction of a whole network of new canals is or is not expedient. It is, at all events, certain that the existing canals could not, even as the result of a large outlay, have any appreciable effect on the railway system which ramifies all over the country, until it is difficult to find even a village which is seven miles from a railway station. The Commission will have to decide not only whether a canal system can be made to pay, but whether it could in any way be made to satisfy modern demands for transport. It may be admitted at once that there are districts wherein water carriage would be useful; but these are so few in number, and of such small commercial importance, that they are of no account. To construct a national canal system which could adequately supplement our railway system and carry mineral and grain traffic at substantially lower rates, though eminently desirable, would involve an expenditure of a vast sum of money. That any reasonable return would be got for this money is, to say the least, doubtful. A proposal to substitute stage coaches and wagons for the passenger and goods trains of the present day would be as rational as the notion that canals can ever again play a serious part in the locomotion of this country. That the canal has its uses we should be the last to deny; but its range of utility is very limited. However, as we have said, we shall be glad to see a Commission appointed to examine the whole question of inland water communication. Perhaps it can succeed in setting the question at rest for a few more years, and even that would probably be worth the money which the proposed inquiry will cost.

RAILWAYS IN INDIA.

The reports which have recently been issued by the principal and less important Indian railway companies for the past financial half-year show, on the whole, a satisfactory rate of progress both in regard to the improvements effected in the permanent way and the construction of new lines, if not also in relation to the commercial results realised for the six months. The main difficulty in the way of the building of extensions of the guaranteed or State-owned railways is overcome by the financial support rendered by the Government, of which the large vote passed by Parliament in the last session is a striking example, and it would seem as if the provision of rolling stock is also largely facilitated by the State. For instance, just prior to his departure from India, Lord Curzon, in the course of an address delivered before the Bombay Chamber of Commerce, referred to the attention which he had devoted to the problem of obtaining an adequate supply of rolling stock during his administration. The late Viceroy is reported to have stated that the deficiency of rolling stock has represented one of the most pressing and severely felt of the difficulties encountered on the Indian railways for a long time past, and he added that during his tenure of office the number of locomotives has been increased by 28 per cent., passenger coaches by 21 per cent., and goods wagons by 33 per cent. These figures, which indicate a favourable stage of development, are of general application, as the condition of individual companies varies. In the case of the Bombay, Baroda, and Central India Railway Company, the permanent way and the rolling stock are described as being in a most satisfactory state, and fully equal to the requirements of commerce and travellers. On the other hand, while the permanent way of the Great Indian Peninsula Railway Company is by no means inferior in any way to the Bombay and Baroda line, the company's rolling stock is quite inadequate to the demands made upon it. In fact, the need for large additions is of an immediate character, and if it is not soon met, apparently by the State Railway Board, the railway will not be maintained on the level necessitated by the requirements of the public.

The most important event in the Indian railway world—apart from the considerable vote adopted by Parliament for extensions and equipment of lines—in the past year has been the arrangement of terms for the State purchase of the undertaking of the Bombay, Baroda, and Central India Railway Company. One by one the old guaranteed lines are being expropriated by the Government as the periods of the concessions enjoyed by the companies gradually draw to an end. The Great Indian Peninsula Railway, which was acquired by the Government in 1900, is still worked by the company by virtue of an agreement extending over twenty-five years from the date of purchase. As State property the length of lines operated by the company at the beginning of last July was 2806 miles, this not including the exercise of running powers over a short mileage of foreign lines. The East Indian Railway Company worked a length of 2262 miles in the past half-year, and nearly 400 miles of additional track are in course of construction. A noteworthy fact in connection with the undertaking is afforded by the ascertainment that in the six months the average charge for carrying a passenger the distance of a mile was one-fifth of a penny, whilst the average rate for the transport of a ton of goods amounted to one-third of a penny per mile. In the case of the Bombay, Baroda and Central India Railway Company, whose undertaking is now passing into possession of the State, the total mileage worked is 2423 miles, of which a small portion is already Government property. The railway is, however, to remain in the hands of the company as the working agency, in a manner similar to that followed in the instance of the two railways previously mentioned, and the reconstitution of the company is in contemplation for this purpose. Another undertaking which is liable to expropriation in 1907 is that of the Madras Railway Company. According to a recent statement made by the chairman, the Madras railway is the last of the old guaranteed railways, and there is, in his opinion, little doubt that the Government will purchase the property when the time arrives for action to be taken in this direction.

The exercise of the right of expropriation, however much we may object to Government ownership and control of undertakings which are best left in the hands of private companies, is only what must be expected on the lapse of existing concessions or agreements, and in the absence of powers held in perpetuity by the companies. When once a start has been made and then repeated in the transfer of properties to the State there is apparently determination to continue the process to the end, and in the case of railways in India the construction of Government lines and their leasing to companies have merely added zest to the intention to nationalise the railways as far as possible. But the fatal mistake of State working the purchased undertakings has fortunately been avoided—at all events, for a number of years, when a fresh decision will have to be made on the expiration of the operating contracts. The purchase of the railways has been accompanied by the conclusion of agreements with the old companies for working the lines they have built, developed, and brought to the present position of prosperity, and there is hope that the policy of leasing expropriated lines to the former owners will be continued in the future. This represents one of the two merits which attach to State ownership of Indian railways, the other being the exceptionally favourable facilities which are available to the operating companies of obtaining from the Government considerable sums of money on low terms for the purpose of necessary extensions and improvements in the railways.

CONGRESS OF CAPITAL CITIES.

A curious proposition has been made within the last few days by Sir Edwin Cornwall, the Chairman of the London County Council. Quite widely speaking, the suggestion is that at regular intervals there shall be held in some one or other of the cities of Europe and America, possessing half a million inhabitants or more, a congress of representatives of the capitals of the civilised world. The primary object of such a congress would be to discuss and study problems which are common to all large centres of population. We must, presumably, take the proposal seriously, and credit Sir Edwin with a desire to do the best possible for London and the rest of the world, but the scheme does not appeal to us, for the knowlegde obtained would, we are convinced, be purchased at too high a price. There are already many visiting institutions—the Association of Municipal Engineers, to quote one that applies most closely to the particular case—and the representatives of the large capitals of the world are not doing their duty if they do not use their present opportunities of making themselves thoroughly conversant with what is going on in other places. These various societies travel abroad at their own—and not at the ratepayers'—expense, except that municipalities send their own representatives; and complaints of the expense involved in doing so are not wanting. What, then, would be said of the far greater outlay that Sir Edwin Cornwall's scheme would unquestionably involve? Further, in the various journals of the different countries if our authorities would but study them, are described minutely all that is going forward. Hence, there are at present existing ample means of intercommunication so far as actual facts are concerned. The regret is that more advantage is not taken of them. Doubtless, intercourse between nations is good and to be encouraged, but we do not think that anything would be obtained by the present suggestion which cannot be had more cheaply

under present conditions. The expense to each capital in turn would be serious. Of course, we can hardly expect the London County Council to take cognisance of that, but it is not improbable that the ratepayers will.

"THE ENGINEER."

WITH our issue to-day the one hundredth volume of THE ENGINEER is completed. Fifty years ago, on January 4th, 1856, our first number appeared, and in the time that has elapsed since then mechanical engineering has developed from small dimensions into the enormous industry of to-day; many of the most striking feats of civil engineering have been witnessed, and electrical engineering with the branches of our profession which are allied to chemistry—all many years younger than THE ENGINEER itself—have sprung into existence. Our pages have faithfully reflected each step of progress as it was made, and we may, therefore, justly and proudly claim that no more complete history of engineering during the fifty years that they cover is to be found than that contained in the one hundred volumes of THE ENGINEER.

THE EARNING POWER OF BRITISH ROLLING STOCK FROM 1894 TO 1904*.

By W. POLLARD DIGBY.

VI.—THE NORTH-EASTERN RAILWAY.

THIS system serves an area which is somewhat restricted, but one in which competition is limited. In the counties of Northumberland and Durham, and in the greater part of the North Riding, there are no competing lines to be combated. It has to handle between York and Berwick a large amount of through passenger traffic, while it has also to maintain large suburban traffic in the colliery, manufacturing, and residential suburbs of Newcastle, Sunderland, Stockton, and Darlington. Its chief revenues are from its freight traffic, and the price of North-Eastern stock is not a bad index of the commercial outlook on the North-east Coast. Quite apart from the extensive coal trade, the iron and steel and allied industries of this district provide a heavy traffic, and while the agricultural produce collected within its own area is relatively slight, it has to maintain an efficient distributing service in imported foodstuffs to its many centres. The rolling stock for dealing with this traffic has increased, as indicated in Fig. 1. Locomotives increased in numbers from 1830

(I)

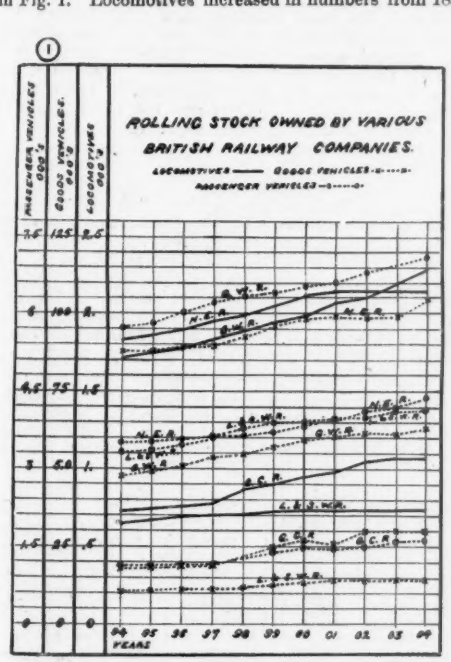


Fig. 1

in 1894, to 2142 in 1901, and have not increased in numbers since then, the large and powerful engines which have been turned out at Gateshead merely balancing an equal number of old and lighter engines withdrawn from service. The increased haulage capacity at normal rates of speed has enormously increased, and were statistics available under this head, there would be no apparent flattening in the curve, such as that which now depicts the only indication we have of the available locomotive power of this line. Passenger vehicles, which amounted to 3498 in 1894, increased to 4373—including 56 electric motor coaches, and 32 trailer coaches for electric trains—by the end of 1904. Goods vehicles increased from 87,452 to 104,248. As is indicated in Fig. 1, the greater part of this increase took place before 1900, when comparative stagnation followed until the end of 1903.

Comparing the percentage increases during eleven years with those which took place throughout the United Kindgom generally, it will be seen that on the North-Eastern system as a whole, the locomotive increase has been 17 per cent. against 22 per cent.; the passenger coach increase has been 25·3 per cent. against 21·7 per cent.; and the number of railway-owned goods wagons 19·2 per cent. against 20·9 per cent.

The course of the gross and net earnings is illustrated in Fig. 2. The passenger earnings amounted to £2,255,595 in 1894, and reached the value in 1901 of £3,013,898, when a set-back occurred, followed by a recovery to £3,039,742 in 1904. Increase under this head was hindered by electric tramway competition, a competition which was countered by the electrification of the North Tyne suburban lines between Newcastle and the sea.

Goods earnings rose from £4,913,888 in 1894 to £6,080,110 in 1900, comparative stagnation following, the figures for 1903 and 1904 being £6,019,227 and £5,956,306 respectively. Gross traffic earnings rose from

(II)

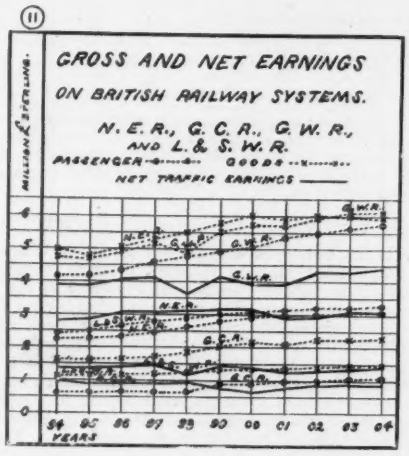


Fig. 2

£7,169,493 in 1894 to their maximum of £9,025,004 in 1903, the figures for the succeeding year being a fraction of one per cent. less at £8,996,048 in 1904. Net traffic earnings, the figure which most interests the shareholders, reached their maximum of £3,198,762 in 1899, having risen to that value from £2,787,012 in 1894. The decrease in net earnings which followed after 1899 has not been so severe as might have been anticipated for a railway so largely dependent on industrial activity within its areas, the latest figure for 1904 standing at £3,053,639. Comparing the respective figures for 1894 and 1904 with those for the United Kingdom as a whole, the gross receipts from passenger traffic increased by 34·8 per cent.—compared with 31·2 per cent.—and the gross receipts from goods traffic by 24·1 per cent.—compared with 27·0 per cent.

Passing next to the earnings per locomotive, Fig. 3 contrasts the gross and net earnings of this system with that of the United Kingdom as a whole, and with three other railways. A reference to page 410 will permit comparisons with three lines previously discussed. The North-Eastern gross earnings per locomotive are considerably below the average for the United Kingdom as a whole, and below those previously recited for individual lines. Starting in 1894 at £3918, they rose to £4282 in 1900, and after a decline, rose to £4200 in 1904, giving a small increase of £282 per locomotive, or 7·2 per cent., which may be compared with an average increase for the United Kingdom, as a whole, of £295 over the gross earnings in 1894 of £4353 per locomotive for the whole of the British railways regarded as a single system. The net earnings per locomotive on the North-Eastern Railway were £1523 in 1894, £1616 in 1896, £1356 in 1901, and £1426 in 1904; the difference between the first and last years of the period under review is therefore £97, as against a decreased net earning of £241 per locomotive for the United Kingdom, the net decline being only 6·4 per cent. The gross earnings per passenger vehicle—see Fig. 4—rose from £645 in 1894 to £757 in 1901, subsequently falling to £695 in 1904. These values are throughout in excess of the average. How much of the recent fall is due to cheap week-end and excursion tickets, for which this line specially caters, is not easy to say. The earnings per company-owned goods wagon are, on the other hand, below the average for the United Kingdom. Starting at £56 per goods vehicle in 1894, the average earnings rose to £69 in 1900, and declined to £59 in 1901. The figure for 1904 is £57.

How far the recent decrease in locomotive earnings is due to locomotive cost pure and simple may be judged from Table I.:—

Before passing to the consideration of other systems, reference must be made to the statistical reforms intro-

(III)

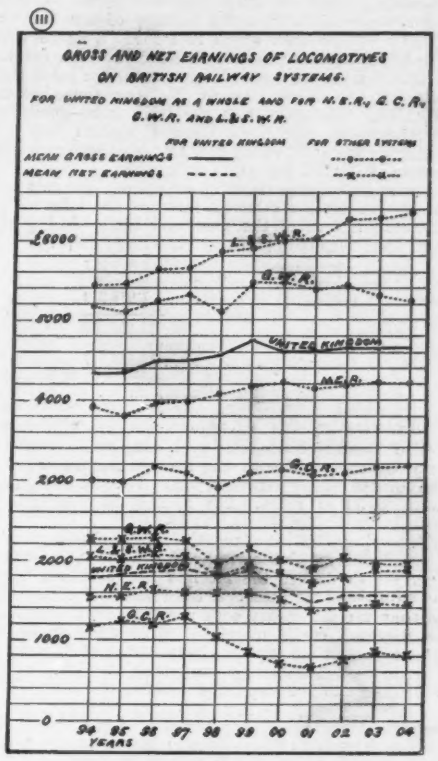


Fig. 3

duced on the North-Eastern Railway, where ton-mile statistics have been collected for some little while. Sir

(IV)

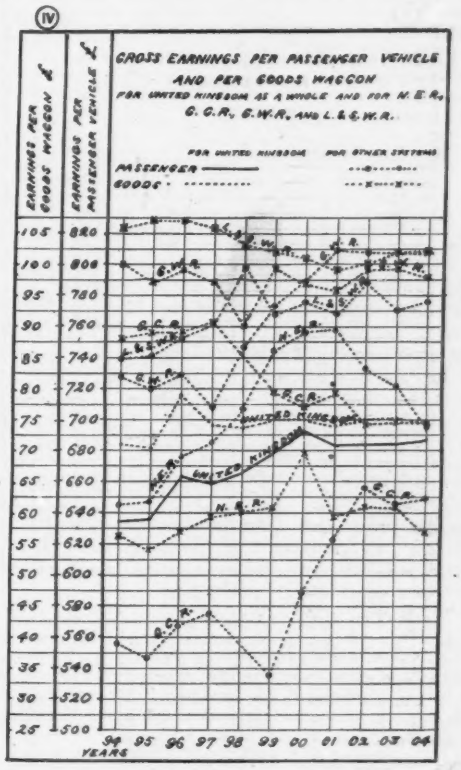


Fig. 4

George Gibb has very courteously forwarded to the writer the following particulars concerning the freight traffic during 1904:—

TABLE I.—*Wages and Fuel Costs for North-Eastern Locomotives.*

Year.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
	£	£	£	£	£	£	£
Total wages cost of working locomotives	502,649	542,088	591,423	578,744	558,489	545,319	513,071
Total cost of coal and coke for locomotives	315,123	372,132	530,099	490,911	419,898	413,528	380,384
Wages cost per locomotive	252	265	279	270	261	255	240
Fuel cost per locomotive	158	182	250	229	196	193	178

The wages cost per locomotive rose from £252 in 1898 to £279 in 1900, and has since been reduced to the low figure of £240. The fuel costs per locomotive, which were identical with those of the London and North-Western Railway in 1898 at £158, only rose to £250 in 1900, and have since fallen to £178, an amount lower than that of any other line.

Route, miles worked	163
Tons carried, including free hauled	53,961 3
Tons carried, excluding free hauled	52,370 112
Ton-miles, including free hauled	1,224,294,792
Ton-miles, excluding free hauled	1,182,112,708
Average distance, in miles	22·69
Train miles	12,215,620
Train load, in tons...	100·22

* The first and second instalments of this article were respectively published in THE ENGINEER of September 22nd, page 279, and October 27th, page 410.

Compared with train journeys and loads in America, these figures are rather small. One particularly interesting point is that they enable us to obtain the exact receipts from the haulage of one ton for a distance of one mile, which is 1·159d., a figure which may be contrasted with the American average earnings of 0·3815d. per ton-mile. The revenue per goods train-mile on the North-Eastern Railway thus becomes 116·155d. The mean cost per train mile—goods and passenger—on the North-Eastern system for 1904 amounted to 49·37, which thus leaves an apparent credit margin of 66·78d. per goods train mile.

Passenger mileage statistics are not continuously computed, but certain selected months are taken. The following figures of the passenger traffic during May, 1904, have also been given by Sir George Gibb:—

Passenger journeys	4,840,927	
Add season ticket holders' journeys (estimated)	1,974,212	
		6,815,139
Passenger miles	74,587,163	
Add season ticket mileage (estimated)	18,557,597	
		93,144,760
Average distance per journey (miles)		13·7
Train miles		1,211,854
Passengers per train		76·9

The average distance of each journey is small and may be compared with the average for the whole of the United States railways, where it amounted during 1903 to 30·10 miles. The number of passengers per train in the United States was 46.

Assuming that the month above cited coincided approximately with the average for the year, it would be possible to deduce the receipts per passenger mile—0·6527d.—and per passenger train mile—50·173d. Compared with the mean cost per train mile, this leaves an apparent credit margin of 0·80d. per train mile. These margins are apparent but not real, as it is impossible to allocate the items comprising the total working expenditure to the respective services.

VII.—THE GREAT CENTRAL RAILWAY.

Measuring from Marylebone to Manchester, the length from north to south of this system is much longer than the distance, say, from Doncaster to Berwick. Branch lines are fewer, and while several large centres are linked

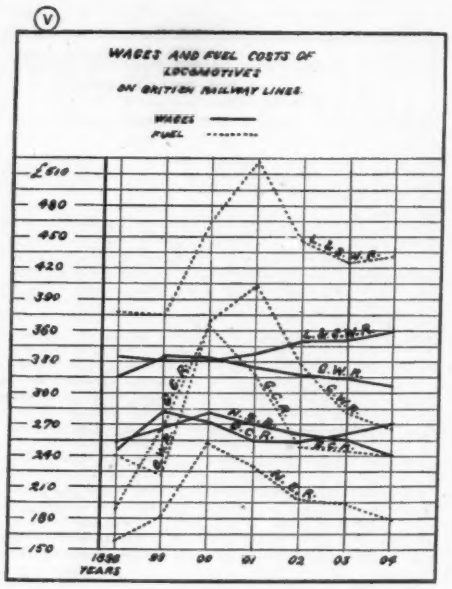


Fig. 5

up by the Great Central Railway, it serves no group of ports like those on the North-east Coast, in regard to which the North-Eastern Railway has a monopoly. It has competitors seeking traffic in almost every town of moderate size, and absolutely no suburban traffic in the London area, to which the line formerly known as the Manchester, Sheffield, and Lincoln, now extends.

The number of locomotives in use has increased from 735 to 1063, this figure including locomotives owned on a hire-and-purchase agreement. Passenger vehicles have increased from 1106 to 1631, and goods vehicles from 18,024 to 30,986, in each case rolling stock in use on a hire-and-purchase agreement being included. Owing to the very great increase in the mileage worked, no useful purpose would be served by stating the percentage increase during the eleven years under review. As regards the earnings of the system, passenger earnings have increased by 72 per cent., from £613,614 in 1894 to £1,056,989 in 1904; and goods earnings by 38 per cent., from £1,592,083 to £2,296,325. The net traffic receipts have fluctuated rather widely, falling steadily from 1898 to 1901. The subsequent rise has brought them to their earlier level, the 1904 figure being £848,604, as against £856,396 in 1894. The net receipts, therefore, have not advanced as the gross receipts have done, the reason, of course, being that the increased mileage resulted in an increase in working expenditure, and the new extension needed more traffic than was immediately available to make it meet its expenses.

The gross earnings per locomotive do not show any retrogression, but on the whole a slight increase of about 3 per cent., the gross earnings being £3061 per engine in 1894 and £3154 in 1904. The net earnings fell to a very low figure, and have not yet retrieved their former position. Starting at £1165 in 1894, the maximum of £1279 was reached in 1897, after which they dropped to nearly one-half, £650, in 1901, subsequently recovering to £863 in 1903, and standing at £798 for 1904. On the other hand, the gross earnings per passenger coach have risen from £555 to £648, but the earnings of company-owned goods wagon have declined from £88 to £74.

The wages and fuel costs per locomotive given in Table II. show how the wages costs have risen lately; they were £270 in 1904 as against £244 in 1896. The fuel costs rose from £188 in 1898 to £363 in 1900, and fell to £240 in 1904, the curve representing these fluctuations being a typical one.

TABLE II.—*Wages and Fuel Costs for Great Central Locomotives.*

Year.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
	£	£	£	£	£	£	£
Total wages cost of working locomotives	210,844	251,675	259,494	251,563	263,613	276,751	287,104
Total cost of coal and coke for locomotives	162,320	241,646	350,436	317,030	260,836	259,094	255,639
Wages cost per locomotive	244	280	271	254	252	260	270
Fuel cost per locomotive	188	268	363	320	249	244	240

VIII.—THE GREAT WESTERN RAILWAY.

This line, despite its connections to South Wales and to the western midland counties, depends to a larger extent on its passenger traffic than does any of the lines previously discussed. The mineral traffic of South Wales is largely carried by independent systems, such as the Taff Vale, Barry, and Rhymney lines. The bulk of the area served by the Great Western Railway is a non-manufacturing one, and the ports of Bristol and Plymouth do not contribute in any special degree to the traffic. The increase in rolling stock recorded in Fig. 1 is a large one, the number of locomotives increasing from 1713 to 2279 (a percentage increase of 33·0), passenger vehicles from 5701 to 7102 (a percentage increase of 20·0), and company-owned goods vehicles from 47,583 to 63,086, a percentage increase of 32·6 per cent.

The gross receipts from the passenger traffic have increased year by year without any set-back, having risen from £4,142,773 in 1894 to £5,739,340 in 1904, a percentage increase of 38·5 per cent. The continuous expansion of the goods traffic was interrupted by a decline in 1898, and the total increase from £4,743,413 in 1894 to £6,170,560 in 1904 is only 30·1 per cent. The net traffic, although higher in 1904, when the amount of £4,370,244 was reached, only shows a small increase of 13·4 per cent. on the figures for 1894 of £3,853,482. The net receipts fell suddenly to a low value in 1898, and although they regained their 1897 level in 1899, they receded until 1901, since recovering.

Apportioning the gross and net earnings among the various classes of rolling stock, a high average for the gross and net earnings per locomotive is at once apparent, these being more greatly in excess of those for the United Kingdom as a whole than is the case on the Great Eastern Railway. Starting from 1894, when the gross earnings per locomotive were £5187, the fluctuations indicated in Fig. 3 resulted, the final figure of £5226 was reached in 1904. The retrogression since 1902 is somewhat unusual, the general results being either those of a rise or of stability for the last three years. The net earnings have been throughout very high, being £2255 in 1894, and £1918—their lowest value—in 1904, the net decline in eleven years being 17·5 per cent. The gross earnings per passenger vehicle have reached a very high value, having increased from £727 in 1894 to £808 in 1904, a value in excess of that earned on any trunk line. The freight earnings reckoned per company-owned goods has also been high, having varied between £96 and £100.

The locomotive expenses for wages and fuel are set out in Table III. The wages cost has not been subject to any great fluctuation; in 1898 this amounted to £314; it reached its maximum in 1899 and 1900 of £336, since which period the cost has fallen to £308. Fuel costs, on the other hand, which were £240 per engine in 1898, reached the very high figure of £408 in 1901. The cost in 1904 was £264.

IX.—THE LONDON AND SOUTH-WESTERN RAILWAY.

Inasmuch as this system and the Great Western Railway are competitors in the extreme west of England, it is appropriate that they should be considered in succession. The London and South-Western Railway taps no coal-fields or great manufacturing centres, but has for its special preserve the port of Southampton. It has, in addition, a very large suburban traffic, which its sister system cannot match, by reason of the remoteness of Paddington from the City in comparison with the less unfavourable situation of Waterloo. The characteristic feature of the importance to the revenue account of the passenger earnings on the Great Western Railway is accentuated in the case of the London and South-Western Railway, where the passenger earnings exceed those from the freight traffic by over 100 per cent.

As regards the rolling stock, the locomotives have increased in numbers from 649 to 736 (or 13·4 per cent.), the passenger vehicles from 3346 to 4139 (nearly 24 per cent.), and the goods vehicles from 10,315 to 14,283 (about 38 per cent.). The earnings from the passenger traffic have risen from £2,434,005 to £3,201,770, and from the goods traffic from £1,093,837 to £1,462,478, no decline under either head taking place in any year between 1894 and 1904, the increase being greater under the latter than under the former heading. The net traffic receipts, which in 1894 were £1,313,962, reached their highest value in 1897, viz., £1,428,824, and their lowest value, £1,239,833 in 1901. The net traffic receipts in 1904 were £1,388,844.

Apportioning these receipts among the rolling stock, it will be seen that the gross earnings per locomotive reach a very high figure, in excess even of that recorded on the Great Western Railway, and have risen continuously from £5436 per locomotive in 1894 to £6348 in 1904. Net earnings were £2025 in 1894, £1689 in 1901, and £1887 in 1904. Compared with the Great Western for the last-named year only, the net receipts are £31 less, although the gross earnings were £1122 more. The earnings per passenger vehicle have not kept pace with the parallel advance on the Great Western system, where these earnings were initially lower. Omitting the fluctuations which are recorded in the diagram, the advance on the London and South-Western Railway was from £727 per passenger vehicle in 1894 to £775 in 1904. The earnings per company-owned goods vehicle have varied between £107 and £102. The wages cost per locomotive, which was £334 in 1896 and £330 in 1900, rose to £359 in 1904. More serious than this rise is that due to the cost of fuel, which was £377 in 1896, £522 in 1901, and was £431 in 1904. The fact that each locomotive in use cost in 1904 £167 more for fuel than was paid on the Great Western Railway, £191 more than was paid on the Great Central Railway, and £253 more than on the North-Eastern Railway, indicates the importance to a railway company of tapping one or more coalfields.

TABLE III.—*Wages and Fuel Costs for Great Western Locomotives.*

Year.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
	£	£	£	£	£	£	£
Total wages cost of working locomotives	591,790	649,719	667,373	666,878	667,522	688,059	700,763
Total cost of coal and coke for locomotives	451,901	538,285	731,272	831,571	683,817	615,896	601,553
Wages cost per locomotive	314	336	336	324	317	313	308
Fuel cost per locomotive	240	222	367	403	325	280	264

TABLE IV.—*Wages and Fuel Costs for London and South-Western Locomotives.*

Year.	1898.	1899.	1900.	1901.	1902.	1903.	1904.
	£	£	£	£	£	£	£
Total wages cost of working locomotives	234,633	231,040	241,972	247,951	256,030	258,692	263,931
Total cost of coal and coke for locomotives	264,487	272,427	339,326	382,908	327,396	311,869	317,382
Wages cost per locomotive	334	331	330	338	349	351	359
Fuel cost per locomotive	377	374	463	522	446	424	431

CRYSTAL PALACE ENGINEERING SCHOOL.—The Wilson premium for the best paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to W. L. Wilkinson for his paper on "Building and Road Construction in India." Other papers read during the session were "Motor Car Construction," by J. R. Barnes; "The Construction of Tube Railways," by A. W. Agnew; and "The Electro-thermal Treatment of Metals," by D. Gollan. The premium was presented to Mr. Wilkinson by Sir William Mather, on the occasion of the ninety-ninth distribution of certificates at the above school, on Thursday, December 21st, at which he presided.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ADMIRALTY POLICY AND NAVAL ENGINEERS.

SIR,—In your issue of December 8th you deal, in a leading article, with the policy projected in the new Naval Blue-book called "A Statement of Admiralty Policy," and from the general tenour of your remarks it is quite evident that you have hailed with delight the many revolutionary statements contained in the said Blue-book. In fact, you state, "that we have nothing but praise for the policy." That is a most courageous attitude, but the wisdom of it I hope you will allow me to question. Like yourself, with much that is contained in the "statement," I am only indirectly concerned, so I only intend to traverse those points raised in your leader of the date referred to.

First, you are unduly optimistic if you think that the future commissioned engineer officer of the Royal Navy will be as competent and as well equipped for the general engineering purposes of the service as the one he is dispossessing. How is he to acquire the knowledge? He is not to specialise until he has become a sub-lieutenant. Up to that stage, from boyhood, he has been learning his profession as a naval officer, and the curriculum for that profession is extensive and varied, for it embraces both a theoretical and practical training in many abstruse subjects, the principal one of which is in acquiring the "sea habit" and the faculty "to command." Sandwiched in between his multifarious duties and studies as a cadet and midshipman, he has had some workshop practice, to make him handy with the tools used by engineers. This training, without any deduction being made for sickness or leave, amounts to about fifty-two weeks. Fifty-two weeks at moulding, pattern-making, fitting, turning, and machine work generally and smithery—roughly, about ten weeks at each trade. I put it to you, Sir, as the editor of a great engineering journal, is it possible for a youngster, be he as clever as a Stephenson, to get more than an elementary knowledge of even one of the trades enumerated, if all the scheduled time for the studies were devoted to engine fitting solely?

That is the loose kind of bed-rock on which the future engineer officer of the Royal Navy will have to build. The present Keyham-trained engineer officer, who has had the advantage of one of the best engineering training schools in the world, devoted more than two-thirds of his training period to manual work, and the more candid amongst the Keyham-trained officers are ready to admit that, as mechanics, they leave a lot to be desired. Unless the future naval engineer is to build his specialised knowledge upon a firmer foundation than the one referred to his specialisation will be in vain. He will be a mere puppet in the hands of the artificer engineers. A "show" officer and nothing more. It must also be borne in mind that when the specialisation in engineering commences manual training is not to be a part of it. The Blue-book specially refers to this, for on page 15 it states:—"No manual work will be included in this course—special engineering—as the officers will all have a sufficient knowledge of practical workmanship."

It is not contended by the present writer that a high degree of technical skill in any one trade in engineering is necessary for the making of a very competent naval engineer officer; but what is submitted is, that unless the future officer gets a more detailed insight into all the "kinks" and mysteries of the various trades he will be at the complete mercy of the trained mechanics that he will have to supervise and give orders to. Your influence, Sir, should be thrown in the balance against this very amateurish attempt to make bricks without straw.

The foregoing, however, is only one of the points on which I would join issue with you on this question of the training of the *personnel* in the engineering department, and I desire now to deal with the Admiralty's intention of turning stokers into watch-keeping officers in the engine-rooms. At the outset let me state that the granting of warrant rank to the fireman class is a just and well-merited recognition of a class that has none too many friends to advocate its claims, but which nevertheless is one of the hardest worked branches of the Royal Navy. Warrant rank might have been conceded on the existing merits of the stokers, but as to whether the new class of stoker should be brought into being to supersede the artificer is a question which raises many important and far-reaching issues, a few of which I will now proceed to deal with.

To quote your own words from the article in question, you state: "We turn now to a matter of very great importance, namely, engine driving." I quite agree with you; it is a matter of *very* great importance, and yet the Admiralty—and, apparently, with your approbation—propose relegating this very important duty to the firemen. No one can quarrel with your dictum about "men highly trained in mathematics, thermodynamics, and science generally," not being required for "the drudgery of watch-keeping duties." That was always and must always be a waste of energy. But it is a long drop from such a paragon of a watch-keeper to the humble, unskilled stoker. Unskilled in a mechanical sense must be here understood.

On November 16th, 1900, in a leading article—"Naval Engineers"—THE ENGINEER stated "To keep watch on deck for four hours with small responsibilities is as nothing to keeping watch for four hours in an engine-room, in heat, in grease, in wet, in coal dust, *with a load of responsibility* (italics mine) and an incessant demand for the closest vigilance." And now, when it is proposed to pitchfork firemen into duties wherein there is a "load of responsibility and an incessant demand for the closest vigilance," the proposition meets with your applause. In the same article from which I have quoted you put, in juxtaposition with the highly trained naval engineer, the engineer of the mercantile marine, "holding a Board of Trade certificate, and with Atlantic experience," as being the type of engineer that might with safety fill the place of the highly-scientific Keyham-trained officer. That is a perfectly tenable position, but as the Admiralty already has the equivalent of the mercantile marine engineer in its possession—I refer to the engine-room artificer—what more was necessary, from your point of view, for watch-keeping duties in our ships of war? Much as is my admiration for the artificers, I would not dare to claim such qualifications for them as you are so willing to concede. In your article of the 8th inst., you state:—"We have always maintained that men highly trained in mathematics," &c. &c., and then state that "artificers who have served a long apprenticeship, and are exceptionally skilful workmen, will no longer drive engines, and in their stead engine-room watch-keeping will devolve on stokers;" and further on you clinch the matter by stating:—"Nothing, we think, but good can come of such a system." If I may be allowed to paraphrase the last sentence of yours, I should put it—"Nothing, we think, but disaster can ensue if such a system be adopted."

What is it, Sir, in reality, that is proposed? It is obvious that the highly skilled artificer is to be superseded in watch-keeping duties by the handyman, a reversion to the "Lascar and oil can" theory of a famous admiral of the nineteenth century. The Blue-book states that "in the largest ships only three engineer officers in addition to the watch-keeping officers will be required." The watch-keeping officers to be warrant officer watch-keepers, *i.e.*, stokers, promoted. By examining this a little more closely it is perceived that the watch-keeping stoker warrant officer will be in complete and absolute control of the highly trained artificer who even you admit is too valuable a man to be wasted on watch-keeping duties, and yet his inferior in mechanical ability is to be placed over him in "executive"—I quote the Blue-book—control of the watches. There is something truly Gilbertian in this new scheme. Perhaps you see the humorous side of it, Sir, whilst I am blind to it. Why, such a scheme if carried out will bring about chaos down below in the engine-rooms, and be the death blow, so to speak, to the E.R.A.'s, who have done so much, and are still doing so much, on their own initiative, to equip themselves as competent marine engineers.

It is not even pretended that this "mechanician" watch-keeping stoker warrant officer is to have the advantage of the very meagre opportunities which the Navy affords for his becoming a handyman; for the Blue-book states—page 18—"The existing course of training for mechanicians will, therefore, be modified with a view to these requirements—watch-keeping—since only sufficient knowledge of tools will be required to ensure that he is able to discharge efficiently his watch-keeping duties." Thus, it is proposed to put the intricate and valuable machinery and boilers in our ships of war under the absolute control of "handymen" What would the ocean-travelling public think if the President of the Board of Trade were to issue a batch of regulations to the mercantile marine making it competent for the "greasers" in the Atlantic liners to have full charge of the watches, whilst the matured and technically-trained engineers holding Board of Trade certificates pottered about on deck repairing donkey engines and making small repairs to the relatively unimportant auxiliary machinery of the ship? If such were done there would be such an outburst of righteous indignation that would startle even the tight barnacles that cling round the offices of the Board of Trade. Such a state of things in connection with the Board of Trade and the mercantile marine is unthinkable; and yet its very counterpart is about to take place in the Royal Navy, the existence of which, in the highest state of efficiency, is absolutely imperative for the protection and defence of this island home of ours, and for our wide-reaching dependencies. And yet the Admiralty and Board of Trade are both Government offices, the heads of which both have seats in the Cabinet, and are both responsible to the British public for the upkeep and well-being of their respective departments.

This is the test, Sir: Would the engineering and ship-owning community of this country tolerate such a proposition as that made for the Navy in the merchant vessels of this country? I trow not. It is not yet too late to arrest this short-sighted and badly conceived policy from becoming law. To "scotch," if not to kill, this retrogressive policy in the all-important branch of the Royal Navy should be the work of journals like your own. To hark back again to your article on this subject of naval engineers, which appeared in your issue of November 16th, 1900—"In a nutshell, then, the proposal for discussion is this: Let the engine-room work be done from first to last by a highly-paid crew of *very competent practical men* (italics again, please), with warrant rank if necessary. . . . The engine-room staff ought to be augmented . . . . pay should be very good. Failing this last, the type of men which we have in mind would not be available."

In conclusion, this subject of the engineering *personnel* is too wide and too far reaching to be dealt with in a hurry. There should be no panic legislation in this matter. Additional men in the engine-rooms of our men-of-war are necessary, but, as you state, these extra men should be very competent practical mechanics. On the score of cost alone, they would be as cheap as the "mechanician" watchkeepers and boy artificers. The engine-room artificer brings his mechanical training into the service with him, whereas the two ratings above specified receive their training at the cost of the nation. Already there are sinister rumours that the cost of such training is being hidden in mysterious ways known only to Government officials. Officers originally detailed for instructional purposes are now being gazetted as supernumerary officers, and so on. But this is worthy of fuller and more detailed treatment, and must not be pursued here.

What every engineer has the right to ask is that THE ENGINEER should reconsider its position, as stated in its issue for December 8th, and get back to its unassailable standard for naval efficiency, as suggested in its policy which appeared in its pages of November 16th, 1900. Apologising for the length of this letter, I beg to conclude, enclosing my card.

Abbey Wood, December 25th. EX-ENGINE-ROOM WATCH-KEEPER.

COACH WEIGHTS.

SIR,—I must thank Mr. Rous-Marten for replying in such detail to the queries contained in my letter of the 12th inst., but, his explanations notwithstanding, I must adhere to my previous statement that a train weighing 404 tons, including passengers and stores, on the Caledonian or any northern railway would on the southern lines be officially identified as forty coaches.

I would remind Mr. Rous-Marten that a decade has passed since Mr. J. P. Pattinson compiled his review of the southern railways, and conditions obtaining in 1895 cannot be reasonably upheld as applying in 1905. Four-wheelers, except during the press of holiday traffic—completely in so far as relates to the London, Brighton and South Coast Railway, and in a lesser degree to the South-Eastern and Chatham Railway—have long since disappeared from the main line services, whereas these vehicles during Mr. Pattinson's tours over the southern systems were the predominating type of carriage stock. True, there are many eight-wheelers in service of not greater weight than 18 or 19 tons, but it is equally true that numerous 23 and 24-ton vehicles are running.

Mr. Rous-Marten objects to the Sunday Pullman Limited, as typical of South of England railway operation, but, in view of the fact that no northern company provides a similar train, the Brighton Limited is essentially typical of the south, and, in any case, may surely be instanced as an example of coach computation. However, since Mr. Rous-Marten prefers to confine the point at issue to the prevailing week-day conditions, I will refer to an ordinary service, the 5.45 p.m., ex. Victoria to Brighton. The customary composition in this instance is 9 sixes, 6 eights, and 1 twelve, and the actual weight thus composed, including passengers, &c., is 301 tons, the equivalent of twenty-three coaches, yielding an average weight per official coach of 13·9 tons. A fairer comparison than that adopted by Mr. Rous-Marten, as indicative of the various methods of calculating coach loads—the North-Western and Brighton Railway's "Sunny South Special"—may, too, be cited. This train usually comprises seven 8's and one 12, weighing approximately 220 tons—although not being conversant with North-Western official coach loads, I repeat the weight I quote is given as approximate only. The North-Western computation is 12½, Brighton 16, although, applying the interpretation insisted by Mr. Rous-Marten, the South of England reckoning should be 22.

These are not isolated cases, and, if Mr. Rous-Marten will select at random any main-line train from the time-table, I shall have the utmost pleasure in supplying him with the usual composition, weight, and coach computation, and incidentally I hope in convincing your contributor that the nominal coach considerably exceeds 10 tons in weight.

West Norwood, S.E., December 18th. MONTAGUE F. LONG.

[The above letter calls for no further comment on my part, as it studiously ignores the two principal points (1) and (2) in my footnote to the previous letter by the same writer.—C. ROUS-MARTEN.]

WHY ARE BOILER EXPLOSIONS VIOLENT?

SIR,—I have read with great interest the articles and letters which you have published on the question of "Why are Boiler Explosions Violent?" In connection with this I have been struck by certain facts, and I would like to make the following suggestion on the subject, though I do so with the greatest diffidence, as I am in no way competent to pronounce any opinion on such a matter:—

"It has been shown"—I am now quoting from a well-known, but rather old, book on physics, which is the only reference-book I have by me—"that absorbed air exerts a very marked influence on the boiling point of water. 'Deluc first observed that water, freed from air by ebullition, and placed in a flask with a long neck, could be raised to 112 deg. Cent. without boiling. Donny examined this phenomenon by means of the apparatus depicted.'" I do not give this. "It consists of a glass tube, bent at one end and closed, while the other end is blown into a pear-shaped bulb, drawn out into a point. The tube contains water, which is boiled until all air is expelled, and the open end is hermetically sealed. By inclining the tube the water passes into the bent end, this end being placed in a bath of chloride of calcium, the temperature may be raised to 130 deg. Cent. without any sign of boiling. At 138 deg. Cent. the liquid is suddenly converted into steam, and the water is thrown out into the bulb, which is smashed if it is not sufficiently strong. Boiled-out water, covered with a layer of oil, may be raised to 120 deg. Cent. without boiling, but above this temperature it suddenly begins to boil, and with almost explosive violence." It appears to me that if the same ratio holds good for water boiling under pressure, and on a large scale, then, given certain conditions, all the mechanism necessary to produce an explosion of the most violent nature is present without searching for any further reason, and even without the presence of a layer of oil. I have not access to a file of your back numbers, but it seems to me that, so far as I can recollect, most of these conditions were present at at the explosions you commented on. This holds good even for the economiser explosion mentioned by "W. H. S." in your issue of October 27th last.

I need not point out what these conditions are, as they are obvious, but it seems to me that the effect or result might be precisely of the detonating character that you describe in your leader of October 5th; part of the water would attain the critical temperature—the lower layer first probably—and this, exploding into steam, would hurl the water above, in the line of least resistance, and possibly with destructive effects; on a small scale it might resemble water hammer, perhaps.

December 19th. B. J. P. R.

THE MEANING OF ADIABATIC.

SIR,—In the article which appeared in THE ENGINEER, at page 583, of December 15th, 1905, the writer "R. M. N." very properly quotes several authors to illustrate the confusion which has arisen due to the different meanings given to the word "adiabatic."

If the writer will turn to the fourteenth edition of Professor Jamieson's text-book, on "Steam and Steam Engines, including Turbines and Boilers," he will find the following simple definition:—"Expansion—of steam or gas—doing work without gain or loss of heat from an external source, is termed adiabatic expansion.

"R. M. N." states that "the second meaning given to the term is synonymous to isentropic; that is, without change of entropy. Adiabatic and isentropic are used as if they meant exactly the same." Here the word "isentropic" should, I think, be spelt, "iso-entropic," since the prefix "iso" is derived from the Greek adjective *isos*, meaning, equal to, or the same as. Swinburne, in his book on "Entropy," says "Text-books frequently treat isentropic and adiabatic as synonymous terms—a very widespread error, arising, like the others, from ignoring real as opposed to hypothetical thermodynamics."

So many different terms for so many actions and effects have been coined, that it is high time engineering technical terms and symbols were thoroughly systematised and standardised. Who will undertake this task?

A.M. INST. C.E.

Glasgow, December 21st.

GLOBE LIGHTNING.

SIR,—The correspondence *re* "Globe Lightning" in your issues of September 15th and 22nd last shows that very few people have been fortunate enough to see this phenomenon. As I am one of the few, perhaps my evidence, though late, may be worth recording. In November, 1901, I was living at the highest point of this island that is inhabited—Curepipe—some 1800ft. above sea level. One Sunday evening my wife and I were returning home about 6 30 p.m., or perhaps a little later. It had just begun to get dark, the moon was well up, the evening was oppressive, and heavy thunderclouds were hanging about. Suddenly a bright light appeared at the edge of one of these clouds, a ball of fire came apparently from behind the clouds and slowly rolled along its under surface, and then apparently disappeared either behind the cloud it came out of, or between it and another one, I cannot say which. I am certain, however, that it did not descend to earth. The globe seemed to me to be a mixture of white and red light, was not perfectly spherical, and changed shape as it moved, as if it were a huge bubble of gas rolling over an irregular surface, if such a thing is possible. Its motion was slow; I have no idea how far it moved before it disappeared, but I certainly saw it for two or three seconds. My wife, whose first exclamation was, "What on earth is the moon doing?" saw it plainly, and so did a number of people to whom I spoke next morning.

If my memory serves me rightly, it is mentioned as being a very rare form of lightning in Silvanus Thompson's "Magnetism and Electricity," and as having been seen by only a fortunate few.

Mauritius, November 2nd. ONE OF THEM.

P.S.—As far as I could hear, no thunder or any sound accompanied the display.

HEBBURN GRAVING DOCK.

SIR,—Referring to the statement in your December 22nd publication of THE ENGINEER, page No. 618, under "Miscellanea," we notice that you have referred to the paper read by Mr. R. S. Fowler, Stud. Inst. C.E., on "Hebburn Graving Dock," and mention our firm as being "contractors" for the dock. We beg to inform you that we are not contractors, but were the engineers for the dock. The contractors for the work were Messrs. R. McAlpine and Sons, of Glasgow.

Edinburgh, December 23rd. THOS. MEIK AND SONS.

CATALOGUES.

OTIS ELEVATOR COMPANY, New York.—The numerous types of lifts, both electrically and hydraulically-operated, for which this firm has become famous, are neatly illustrated in the new catalogue. There are also steam hoists, inclined railways, "escalators," &c.

COWANS, SHELDON AND CO., Limited, Carlisle.—The 1906 catalogue of lifting machinery and railway plant issued by this firm is somewhat similar to previous editions, but several new machines are included. Particular attention is now given to machines in which electricity is employed as the motive power. The book is well produced.

BRITISH PROMETHEUS COMPANY, Limited, Kingston-on-Thames.—The electric heater lends itself well to artistic effect, judging from the excellent illustrations of novel designs shown in this catalogue. There are fifty-six different patterns, and all that is now wanted to make electric warming of houses popular is current at a price which will compare with that of gas.

BRITISH URALITE COMPANY, Limited, 50, Cannon-street, London.—A pamphlet from this firm is intended to advertise the use of this fire-proof material for roofing purposes. A large illustration is included, showing a recent extension of the building at Kensington known as Olympia, in which Uralite has been used for the roof, measuring 34,000 square feet. The work was done in four weeks.

DISPLACEMENT OF THE SEMI-ARCHES OF A STONE BRIDGE.

THE Maximilian bridge erected recently at Munich, over the rapidly rolling Isar, was some months ago the scene of an accident of rather a novel and peculiar character. A sketch elevation of the structure appears in Fig. 1. It consists of a pair of stone arches, each of 145ft. span, and 16ft. rise, and is provided with three articulations, one at the crown and one at each of the springings. It may be here mentioned, in reference to what will follow, that the springings of the arches are not placed at the same level. They are, nevertheless, in the same straight line, which is not horizontal but parallel to the road gradient, which is 1 in 50. Between parapets, the width of the bridge is 72ft., which allows of a roadway 40ft. wide, and two footways of 16ft. Limestone is used in the arches, which are of ashlar work, but the voussoirs forming the bed stones for the articulations are of granite, with the exception of those at the crown of the arch.

The arches were turned upon full centres, and were in the state about to be described, when the accident occurred. Both arches were completely finished, and the spandrels were built upon the one to the east of the structure. Upon the west span, however, the spandrel arches—Fig. 1—had not been built, so that the weight was not the same upon both halves of the whole bridge. It was calculated that the weight resting upon the eastern arch exceeded by 33 tons that upon its western neighbour, or about a quarter of a ton per foot run. All the scaffolding and staging had been cleared away from the west span, but not from the other, although the centres had been struck, and the arch was consequently completely independent. The operation of striking the centres was performed upon both the arches at the same time on 13th June, 1904. Each of them had been loaded as symmetrically as circumstances allowed. Between the 13th and 26th of the same month, spandrel arches of the east span were built, and on the 27th the result of some levels taken, showed that the crown of that arch had appreciably risen ¼in. on both faces. About the same time it was discovered that a sliding movement had manifested itself downwards to the extent of 0·8in. in both of the articulations at the springings. This movement continued, and was plainly perceptible. When the displacement had reached 2·4in., the upper half of the articulation separated itself violently from the lower half, and assumed the position seen in Fig. 6, the arch supporting itself once more upon the centering. A contemporaneous movement of a similar description was developed in the western vault, which previously had evinced no indication of sliding, but now severed itself in the same manner as the other span, and remained wedged upon the masonry at each of the two abutments. The springings being, as already stated, constructed of granite, underwent no fracture, but the limestone voussoirs at the crown were shattered to pieces.

It has been estimated that the duration of the descent was two-fifths of a second, until the upper steel shoe rested upon the lower granite bedstone. The noise and the shock were very considerable, and gave rise to an impression that they were due to seismatic agency. A measurement of the vertical descent of the abutments gave the following results, reckoning from east to west:—East span, east abutment, 12·24in.; east span, west abutment, 12·80in.; west span, east abutment, 13·96in.; west span, west abutment, 12·72in. At the crown the subsidence of the east span amounted to 1·08in., and to 4·20in. at the west. For a full critical examination of the construction of the bridge we must refer our readers to a communication of M. W. Dietz in the *Zeitschrift des Vereines Deutscher Ingenieure*. It appears that the articulations employed were according to the ordinary practice followed by the Bavarian engineers in the erection of similar metallic structures. In order to conform as closely as possible to the hypothesis of securing a single-point contact, they use two steel convex plates, or, more generally, one flat and one convex, of large radius. Many examples of this method exist in Bavaria, including the Kaufering Bridge over the Leck. Frequently, perhaps, to make assurance doubly sure, a vertical steel pin is inserted through the two plates to render their position immovable. Since it was scarcely possible to make a single articulation equal in length to the whole width of the bridge, it was decided to divide it into thirty-three separate parts, each having a length of 1ft. 10in., and placed 4in. apart in the clear. Their form, so far as the scale will allow, is shown in Figs. 3 and 5. Steel plates, 4¾in. in length and 1·6in. thick, are fixed to a pair of cast iron shoes. The upper plate has a convex surface, with a radius of 1ft., and the lower a concavity of 10ft. radius. Iron rods, let into the bedstones, hold the lower shoes in position, but the upper are not thus secured, but depend solely upon contact and pressure for their fixation.

At the time of the accident the weight of each arch and the pressure at the springings had been ascertained. Each weighed, after the striking of the centres, 2940 tons, but the weight of the east span was subsequently increased to 3574 tons, as its erection advanced faster than that of its fellow.

The reactions of the supports were calculated for each length of 1ft. 10in. to amount, in tons and decimals, for the east arch to:—Crown, horizontally, 104·20; transversely, 1·828. East abutment, normally, 116·19; transversely, 2·476. West abutment, normally, 117·80; transversely, 1·828. For the west arch:—Crown, horizontal, 92·80; transversely, 1·631. East abutment, normally, 102; transversely, −0·138. West abutment, normally, 103·40; transversely, −1·114. The sign − prefixed to the last two results indicates that the action of the arch upon the supports is exerted upwards. Had the bridge been completed, and the loading superimposed, the reactions would be represented in tons by the following figures:—

At the abutments, 131·61; transversely, 4·604. At the crown, horizontally, 116·70; transversely, 3·367.

From the preceding figures the angles can be deduced, made by the reaction with the normal. Those of the west span were small, not exceeding 0°, 4′, 35″ and 0°, 35′, 11″. It was this arch which did not fail independently, but yielded in consequence of the descent of the other. In the east span the angles were more accentuated, and their value was determined before and after the construction of the spandrel arches, and was the following:—Arch alone, east abutment, 0, 28′, 58″ (*a*); arch alone, west abutment, 0, 1, 59″ (*c*); arch with spandrels, east abutment, 1°, 15′, 30″ (*b*); arch with spandrels, West abutment, 1°, 43′, 29″ (*d*). Taking the mean value of $(a + b)$ and $(c + d)$ we have for the reaction of east and west respectively 1°, 44′, 28″, and 1°, 45′, 28″. From the above tabular statement, the angles for the full loading, at east or west are 1°, 15′, 30″, and 1°, 43′, 29″, which, represented by their tangents, are equal to 0·022 and 0·03, values which are less than the coefficient of friction.

Some explanation appears to be here necessary, as it is difficult at first sight to understand the nature of the results. It is remarked by our contemporary *Le Genie Civil* that the singular idea of carefully polishing the metallic surfaces in contact, and greasing them copiously with stearine was put into execution. The motive for these two operations escapes detection. It was clearly not expected that any movement might occur, but that assumption does not explain in the least why the slipping was so greatly facilitated. It is presumed that the introduction of the central articulation did not in any degree contribute towards the accident. This assertion is possibly open to doubt. Referring to metallic bridges, it must be borne in mind that there are generally conditions obtaining in structures belonging to the arch type which are independent of the material of which they are built. In modern steel arch bridges the employment of hinges or pivots of some recognised pattern at the springings is almost universal, but the same welcome is not accorded by bridge designers to the central articulation. It has been frequently observed with truth, that pivoting at the crown tends to render the bridge shaky or cranky, and the observation applies with greater force to those of stone. There are also instances upon record where the central hinge has been removed, and the arch rendered continuous over the crown. Again, it is not an uncommon practice on the Continent for a bridge to be designed on the three-hinged principle, and the crown hinge to be suppressed in its construction. The position of the central articulation of the Maximilian bridge after the accident appears in Fig. 2. A cross section of the articulation, which is the same for both springings and crown, with the steel plates and cast iron shoes, is given in Fig. 5, and Fig. 6 shows the state of the bearings at the springings after the accident. It is put forward as a probable contingency that the particles of steel in the crown pivot were slightly convex, and that the resulting equilibrium under these circumstances approaches closely to actual instability, which is increased by the slightest movement, and that, apparently, this was precisely what took place. It might be answered that the coefficient of friction which was overcome, 0·022 and 0·030, is so small that it could scarcely exist between surfaces so tightly pressed together as were the steel particles, and that such coefficients were not realisable between the parts in motion. At any rate, the fact remains that the movement was seen and followed for six hours.

A few words may be said here regarding the experiments on friction undertaken in 1901 by M. Tœppl, professor at Munich. In experimenting upon pivoted supports with increasing pressures, with rollers 2in. in diameter, he obtained results opposite to those attending the investigations of Rennie, which related also to high unit pressures. The professor found in all his experiments that a diminution of the coefficient of friction accompanied the higher pressures; a brief *résumé* of his results may be here quoted:—

Steel and cast iron without lubrication	0·235 to 0·216
Machines, oiled	0·191 and 0·192
,, greased	0·171 to 0·148
,, tallowed	0·015 ,, 0·089
,, stearined	0·022 ,, 0·005
,, tallowed and stearined, 1 to 3	0·011 ,, 0·003
,, paraffined	0·006 ,, 0·002

Another statement is to the effect that the position of the centre of gravity may not have been determined with that degree of mathematical accuracy supposed in the calculations. Although the quantities were cubed with the greatest care, it is quite possible that here and there some difference in the density or some slight variation in the dimensions might have been introduced which would have altered the distribution of the loading, and, consequently, the angles of reaction at the supports. When so near an approach is made to the point of instability, a very trifling departure from theoretical conditions may lead to a catastrophe. Though it is not certain that the adoption of semi-cylindrical cast iron bearings, as suggested, would have altogether prevented the accident in question, the following fact is very significant in relation thereto. This description of pivoting was used in the two railway bridges of 200ft. span, designed by the late Sir John Fowler, over the Severn. These bridges were severely tested, but not the smallest movement whatever could be detected in either instance at the springings of the arch. It may be suggested that the different amounts of the loading upon each arch at the time of the accident, equal to 634 tons, was quite sufficient to seriously interfere with the original directions of the lines of pressure. This point is of especially great importance in arches built of masonry.

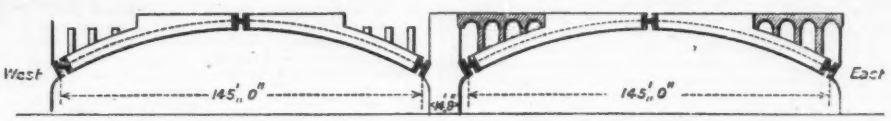


Fig. 1. Elevation

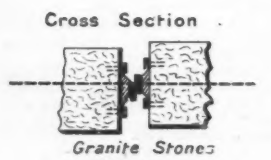
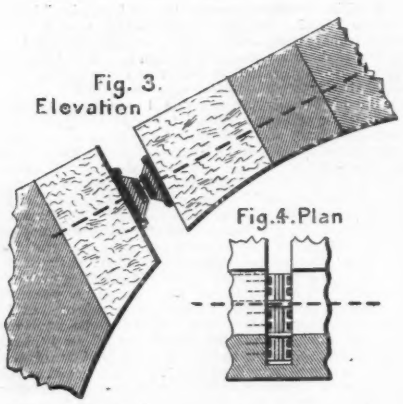


Fig. 2.



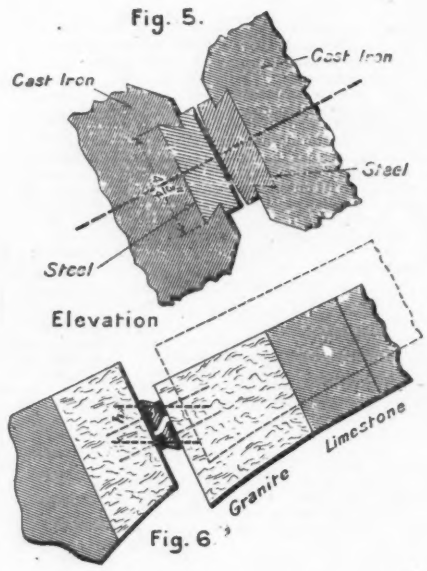


Fig. 6.

"THE ENGINEER" SWAIN Sc

ACCIDENT TO THE MAXIMILIAN BRIDGE, MUNICH

AMERICAN ENGINEERING NEWS.

A reversing gas engine.—A two-cycle gasoline engine for marine and other work has been brought out in the United States, which is reversible in the same way as a steam engine, the movement of a lever causing the crank shaft to revolve in the opposite direction. When the engine is running ahead the governor balls are restrained from flying out by a sleeve, which is withdrawn when the reversing lever is shifted, the balls then fly out and hold it in position, and at the same time act to prevent sparking. The purpose of this is to stop the explosions and cause the engine to lose its momentum, this being necessary before reversing begins. A spring brings the governor balls together before the momentum is entirely overcome, and another spring returns the sleeve to its original position, while at the same time the interrupter is released so that it can again begin sparking. But the shifting of the reversing lever has changed the position of the interrupter, so that the spark occurs before the centre is reached. Consequently, when sparking is resumed, the engine must run in the reverse direction. The momentum has at this time been so reduced that the force of one explosion will cause the engine to revolve in this reverse direction. The time for changing from full-speed ahead to the reverse is about five seconds. An automatic valve in the by-pass prevents the possibility of back firing in the crank case, and is adjustable to regulate the power independently of the timing mechanism. Thus there are two independent controls of the engine: one by regulating the amount of gas admitted to the combustion chamber; the other by timing the explosion. The engine is made in both vertical and horizontal patterns.

Storage batteries for electric tramways.—The use of storage batteries as auxiliaries for electric generating stations is quite extensive in the United States, and an example is afforded by the power plant of the Syracuse and Suburban Electric Tramway. Its use is to carry peak loads, to ensure regulation, and as a reserve. The line is fourteen miles long, with a four-mile branch, and has heavy gradients. At one end is the hydro-electric generating plant; this consists of a 600 horse-power water wheel driving two generators of 225 kilowatts at 650 volts. For reserve in winter, and when the water is low, there is a 500 horse-power engine driving a 600-kilowatt 600-volt generator. Under the conditions of operating, especially with turnouts on the gradients, the voltage would drop as low as 200 volts when the heavy loads came on, or the sharp fluctuations of load occurred. To improve the conditions it was proposed either to change to alternating current or to put in a storage battery plant, and the latter was adopted. There are 240 cells of 9-unit accumulators in glass tanks. The normal capacity is 320 ampère-hours, but the tanks will admit of two additional pairs of plates, increasing the capacity to 480 ampère-hours. The battery acts as a balancing governor to the generating equipment. Before it was installed cars were run every hour; after its installation the company was able to increase the service of cars to every half hour, thus stimulating the traffic. The voltmeter chart shows a very large range of fluctuation, from 200 to over 700 volts, offering a striking contrast and demonstrating the amount of work that is being done by the battery.

THE Japanese armoured cruiser Tsukuba was launched at Kure this week. The occasion, says Reuter, was one of much public rejoicing, this being the first armoured cruiser built entirely in Japan without aid from abroad.

BEHAVIOUR OF MATERIALS OF CONSTRUCTION UNDER PURE SHEAR.*

By Mr. E. G. IZOD, Associate Member, of Rugby.

THE title of this paper being perhaps rather far-reaching, it may not be out of place to explain that in the following series of experiments only the better known and more commercially used materials were tested, though it is hoped that the results obtained may be somewhat of a guide in forecasting results from other materials that do not come within the scope of these experiments. Time was such an important factor in carrying out these tests that the author could not make them as complete as could be wished, but he hopes that some of the results now set forward may be found useful and interesting.

The experiments were carried out at University College Engineering Laboratory, and were undertaken in the first case to investigate the effect of shear on cast iron, concerning which there seemed rather a lack of data, and these proving useful they were extended to embrace a somewhat wider field, as shown in the results attached. The main stumbling block in experiments on shear seems to be that bending, or stretching of the outer fibres in the specimens tested, cannot be entirely eliminated, and to remedy this as far as possible a particular form of shearing apparatus has been used.

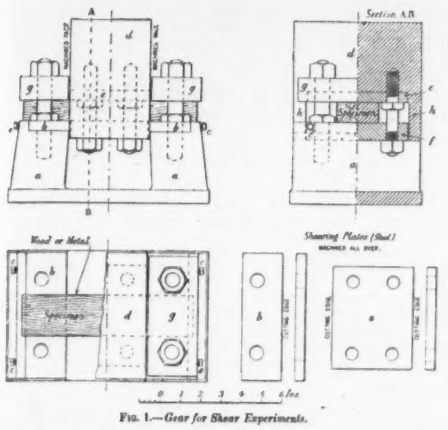


FIG. 1.—*Gear for Shear Experiments.*

The apparatus is shown in Fig. 1. *a* is a stiff cast iron body composed of two projecting supports, which are cast in one with the bed-plate. These supports carry hardened steel plates *b b*, with edges ground for cutting edges; these side plates are screwed to the supports by the holding-down bolts which grip the specimen, the edges being spaced exactly 4in. apart, which is the general span adopted for the experiments. The plates are capable of fine adjustment by means of the small set screws *c c c c*. Between these side plates another cast iron block *d* slides, which also holds a steel plate *e* with cutting edges; this middle plate exactly fits between the two side plates, so that the opposite edges shall induce as near perfect shear as possible. The specimen is then screwed down to the middle plate by means of the cap and holding-down bolts, Fig. 8, and the projecting ends placed on the two side plates and held firmly by the caps *g* and side bolts; the whole apparatus is then placed between the compression plates of the testing machine, and the tests carried out in the usual manner. The projecting lugs *k* served as guides to ensure the middle block *d* moving fairly between the side plates. The apparatus is shown in the testing machine, Fig. 9. The testing machine used was a 100,000 lb. Greenwood and Batley horizontal machine, and all the jockey weights were carefully calibrated. The specimens used were as nearly alike as could possibly be obtained, but a great deal depended on the form in which the material was supplied, this varying with different makers; in all cases a rectangular section was used for the shearing tests, while for the tensile tests a general rule was followed where possible for the flat and round specimens.

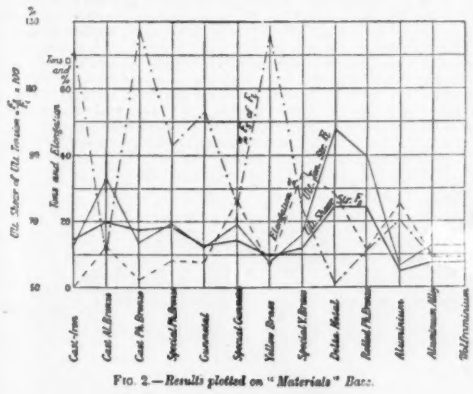


FIG. 2.—*Results plotted on "Materials" Base.*

Several experiments were made in the early stages to determine the effect of form or shape of section on the ultimate shear stress, which perhaps deserves a passing mention. A mild steel bar was taken and specimens cut from it consecutively, and treated in a different manner as regards the shearing area, such as:—(1) Nicked with various widths of cutting tool; (2) fine saw cuts to various depths; (3) turned grooves with various radii at the bottom; (4) recesses machined for the knife-edges, &c. These gave results practically identical with those from the plain bar, so that the rectangular sections as tested could be relied upon to give satisfactory results and an accurate measure of the ultimate shear strength for all materials.

A summary of all the results obtained is shown in Table I., and plotted against materials base in Fig. 2. Each figure in the table is the mean of a large number of separate tests; where the elongation percentage is given, it is the corrected elongation percentage for a standard bar 2in. long and $\frac{7}{16}$in. diameter, having, therefore, a ratio of $\frac{l}{d} = 3{\cdot}54$.

Ultimate tensile strength is designated by F_t.
Ultimate shear stress is designated by F_s.

TABLE I.—*Summary Table of Results.*

Results plotted on "Materials" base, Figs 2, 3, and 5.

Material.	Ultimate tensile stress, Tons per sq. in. = F_t.	Elongation percentage on standard.	Stretch modulus E. Tons per sq. in.	Ultimate shear stress, Tons per sq. in. = F_s.	Per cent. of ultimate shear of ultimate tensile stress $\frac{F_s}{F_t} \times 100$.
Cast iron, A	9·7	—	6000	14·8	152·0
,, B	13·4	—	8300	17·4	111·0
,, C	11·3	—	5700	13·9	122·0
,, D_1	13·7	—	6200	16·1	118·0
,, D_2	13·5	—	5900	14·8	110·0
Cast aluminium-bronze	33·1	12·5	7600	19·9	60·0
,, phosphor-bronze	13·4	2·2	—	17·2	128·0
Special cast phosphor bronze	19·7	8·0	—	18·4	93·0
Gun-metal	12·1	7·8	—	12·5	103·0
Special gun-metal	19·0	26·5	—	14·3	75·0
Yellow brass	7·5	6·5	—	9·4	126·0
Special yellow brass	16·0	35·0	—	11·8	74·0
Delta metal	47·3	28·3	—	24·2	51·0
Rolled phosphor bronze	39·5	11·7	—	24·2	61·0
Aluminium	6·4	25·5	—	4·5	70·0
Aluminium alloy	12·7	9·6	—	7·5	59·0
Wolframinium	12·6	9·2	—	7·5	59·0
Wrought iron bar	26·0	22·5	—	19·4	75·0
Mild steel plate 0·14 carbon	26·9	34·7	—	21·0	78·0
Swedish crucible steel:—					
0·12 carbon	24·9	43·0	—	18·5	74·0
0·48 ,,	42·1	16·0	—	28·8	68·0
0·71 ,,	56·3	15·0	—	36·6	65·0
0·77 ,,	61·3	11·0	—	28·3	62·0

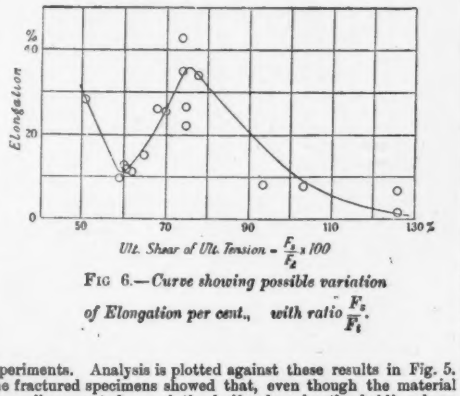


FIG. 5.—*Shear and Tensile Tests of Cast-iron with Analyses of Different Brands.* (Iron represented by difference.)

Cast iron.—Four brands were tested, and the mean results give a higher ultimate shear stress for cast iron than is generally accepted; the average for all brands being 14·9 tons per square inch, while in several cases it exceeded 16·0 tons. An attempt was made to establish a rule as a guide to the ratio $\frac{F_s}{F_t}$, but this ratio did not seem to be dependent on any of the other results observed. Though the variation with different brands is not great, yet it cannot be said to follow any law which can be deduced from these experiments. Analysis is plotted against these results in Fig. 5. The fractured specimens showed that, even though the material was well supported round the knife-edges by the holding-down caps, yet a local stretching took place in the outer skin, in this case, of course, showing as a slight crack across the specimen about $\frac{1}{32}$in. from the shearing plane. It was observed also that the fracture line took the form of an S bend with the bulge towards the knife-edge, as shown in Fig. 10.

FIG. 6.—*Curve showing possible variation of Elongation per cent., with ratio* $\frac{F_s}{F_t}$.

Cast aluminium-bronze.—These specimens have a high ultimate tensile stress with rather low ultimate shear stress, the ratio $\frac{F_s}{F_t}$ being only 60 per cent. The shear fracture, Fig. 13, did not show much sign of the knife edges having had a cutting action on the material, it having apparently stood the load up to the maximum without much deformation, and then entirely fractured at this load. In the tensile tests it was noted that the reduction of area before and at fracture was not local, but extended over the whole length of the bar, breaking it up into corrugated ridges almost as though the material was rolled and fibrous.

Cast phosphor-bronze.—The ordinary material gave a high ratio $\frac{F_s}{F_t}$, and the same material was specially treated in casting, with the result that the whole of the figures were improved, the ratio $\frac{F_s}{F_t}$, however, decreasing from 128 to 93 per cent. A very curious fracture was observed with the special material, which is a very aggravated form of the fracture noticed in mild steel, &c. When the specimen was sheared, it was found that the fracture line had taken two distinct paths in such a manner that there was a plug of the material left in the shear plane, untouched by the knife edges. This fracture appeared in all the shear tests of the special phosphor-bronze, and is shown very clearly in Fig. 17, where there is also shown a shear fracture of ordinary cast phosphor-bronze. This is possibly due to the very homogeneous nature of the special material, as the fracture line has apparently started in a similar manner to that explained in the mild steel tests, but has simultaneously extended to the opposite knife edge in such a manner that there is left the knot or plug of material mentioned above.

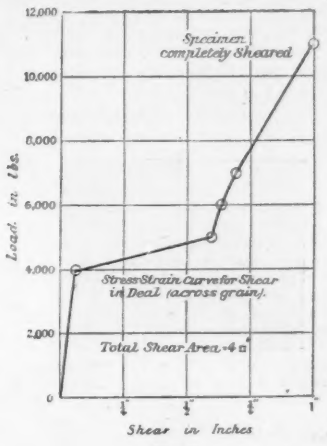

Specimen completely Sheared
Load in lbs.
Stress-Strain Curve for Shear in Deal (across grain).
Total Shear Area = 4 □
Shear in Inches

FIG. 7.

Gun-metal.—In this case, similarly to that of phosphor-bronze, the special treatment has considerably improved the test figures, though the ratio $\frac{F_s}{F_t}$ has dropped from 103·0 to 75 per cent.

Yellow brass.—The improvement due to special treatment is here even more marked than in the two previous cases, though the variation in results is what might be expected from the former tests.

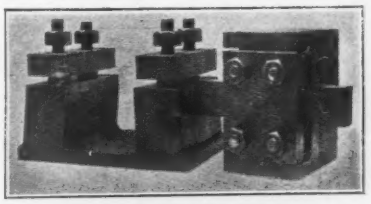


Fig. 8—SHEARING SHACKLES OPEN

Delta metal.—This gave the highest ultimate tensile stress of all the materials, the ultimate shear stress being equal to that of rolled phosphor-bronze, while the ratio $\frac{F_s}{F_t}$ was 51·0 per cent. The shear fracture was fine and clean, but presented a curious feature in that the material showed no trace of cutting of the knife edges except at the extreme outside of the specimen, where the metal had apparently bunched up into a knot, and was either entirely cut by the descending knife edges or else torn clean away, leaving two projections in one portion of the sheared specimen with corresponding recesses in the other. This peculiarity is shown very clearly in Fig. 15.

Rolled phosphor-bronze.—This proved very tough material, with high ultimate tensile stress 39·5 tons per square inch and a fairly low elongation. The ultimate shear stress was 24·2, and there is a rather low ratio $\frac{F_s}{F_t}$ of 61·0 per cent. Shear fracture was very smooth and clean, and showed traces of the knife edges, with very little stretching of the outer fibres.

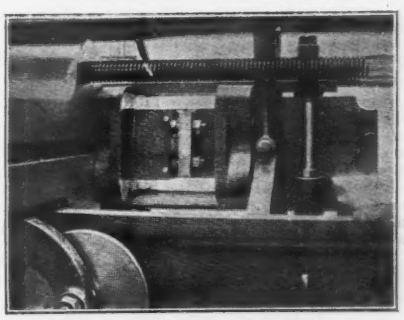


Fig. 9—APPARATUS IN TESTING MACHINE

Aluminium.—This gave fairly high elongation with ratio $\frac{F_s}{F_t}$ of 71·4. Shear fracture was smooth and clean, showing the cutting action of the knife edges very plainly.

Aluminium alloy.—Ultimate tensile stress in this case was nearly double that of aluminium, while the ratio $\frac{F_s}{F_t}$ was only 60 per cent., or 10 per cent. less. Shear fracture showed the peculiar ridge described later in mild steel tests, Fig. 14.

Wolframinium.—This gave results almost coinciding with the former aluminium alloy, the only difference being, if anything, slightly lower elongation percentage. The shear fracture was similar to No. 4 alloy and mild steel.

Mild steel and wrought iron.—It was intended to make these

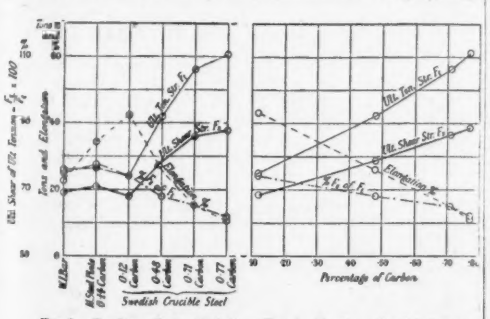


FIG. 3.—*Results on Steel Plotted against "Material" representing various qualities of Steel.*

FIG. 4.—*Results on Swedish Crucible Steel with varying Percentages of Carbon.*

* The Institution of Mechanical Engineers.

tests on a large number of steels with varying percentages of carbon, including the higher carbon steels; but unfortunately steel makers who would have supplied a series of test pieces with their proportionate analyses were not able to furnish them at the last minute, consequently the experiments are not so complete as they might be. The author was enabled to include, however, a series of tests on some Swedish crucible steel, with varying percentages of carbon, and these results are plotted in Fig. 4. Contrary to expectation, the ratio $\frac{F_s}{F_t}$ decreased as the carbon content increased; but the author is inclined to think that this confirms the deductions arrived at from the curve in Fig. 6 and explained later, namely, that as the ratio $\frac{F_s}{F_t}$ falls from 80 to 60 per cent. the elongation percentage also decreases, whereas, if the elongation dropped considerably lower than 10 per cent., as might be expected with higher carbon steels, the ratio $\frac{F_s}{F_t}$ would be proportionately higher.

A very curious feature of the tests on mild steel was the peculiar

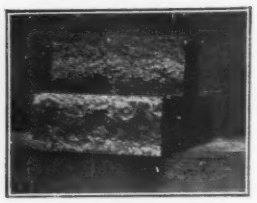


Fig. 10—SHEAR FRACTURE, CAST IRON

form of fracture, there being left a very decided knife edge standing away from the rest of the material, as shown in Fig. 11, and in the specimen exhibited. This peculiarity was noted in two other materials tested; and to investigate it, a specimen of mild steel was specially prepared with horizontal and vertical lines drawn $\frac{1}{32}$in. apart, each side of the shearing plane; this was then placed in the machine and the load taken off when the specimen was half-sheared. The effect of the shearing action is shown in Fig. 12, which are from each end of the half-sheared specimen exhibited. It can be seen that the fracture starts along a line inclined at an angle to the vertical shearing plane, but in an opposite direction to that of cast iron, which was towards and under each respective knife edge, while in this case of mild steel the direction is to the other side of the vertical plane, and away from the knife edge. The cause of the projecting ledge mentioned above is most probably explained as follows:—When the knife edges move towards one another under the gradually applied load, the fracture line starts obliquely from each, and as they come together the fibres of the intervening material are compressed and twisted through nearly a right angle until finally fracture takes place along the fibres. The knife edges separate this isolated

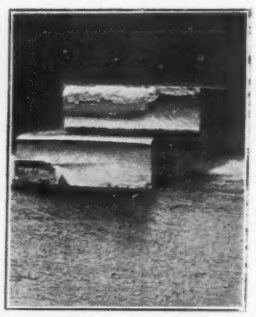


Fig. 11—SHEAR FRACTURE, MILD STEEL

portion through the vertical plane in which they are forced to move, thus making the ridge mentioned, the front of which is due to the cutting action of the knife edge, while the back is due to the primary fracture line at the commencement of the load. This experiment also showed that it was practically impossible to prevent a certain amount of stretching of the top fibres in shearing tests, as, though the material was well supported by the holding-down caps, these fibres were effected for $\frac{1}{16}$in. each side of the shearing plane, as shown by the inclination of the top portion of the vertical lines; this stretching or bending is due to the fact that, when the load comes on the specimen, a certain amount of compression takes place before any fracture occurs, which brings the material away from the holding-down caps, and so leaves it to a certain extent unsupported and free to stretch.

Woods.—Four kinds of woods were used for these tests:—(1) Pollard oak; (2) yellow deal; (3) yellow pine; (4) teak. From a selected board of each, specimens for tension and shear were cut alternately, in order to ensure any possible variation in the quality of the board being well distributed. The shear specimens were cut 8in. by 2in. by 1in., and tested along and across the grain. The results are given in Table II. On testing the woods in shear across the grain, it was observed that the specimen remained steady up to a certain load, and then sheared through about three-fourths of its shearing area, when it required a further increase of load, sometimes as much as twice the amount to completely shear the specimen; the author has named this the "crippling load," and it is shown more clearly in a shear stress-strain diagram, Fig. 7, which was drawn for a specimen of deal sheared across the grain. The exception to this is the case of oak, where no "crippling load" is really apparent, and which sheared through at its maximum load directly the centre knife-edge commenced to move. In teak specimens sheared across the grain, the fibres did not hold together as in the other woods, but broke away from the main specimen at about $\frac{3}{4}$in. from the shearing plane. This is shown in Fig. 16.

The percentage of moisture in each wood was obtained by carefully weighing the broken specimens, then placing them in a temperature of 212 deg. Fah. for 80 hours and weighing again immediately on removal. Towards the conclusion of the experiments it occurred to the author that the apparently pure double shear, induced by the apparatus used, might not be simultaneous over the whole area, and to investigate the matter an arrangement was adopted as follows:—To the centre block carrying the middle knife-edge a stiff steel beam was screwed, each end of which

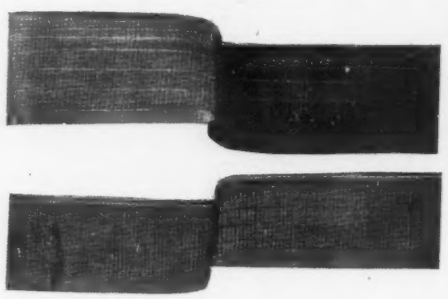


Fig. 12—PARTLY SHEARED SPECIMENS, MILD STEEL

carried a steel pointer; to the crosspiece of the testing machine which carried the compression plate two brackets were fixed which carried smoked iron plates, the steel pointers on the beams resting lightly on each, and were adjusted with springs to move without friction on the plates. The multiplying effect each side of the centre block was, by means of the long steel beam, 16 to 1—that is, a movement of $\frac{1}{16}$in. on the pointer would mean a corresponding movement of the knife-edge of $\frac{1}{256}$in. A specimen was placed in the shearing shackles, and the whole just gripped between the compression plates sufficiently to prevent slipping; the steel beam was then screwed down to the centre block, and the pointers adjusted to just rest lightly on the smoked plates. A zero line

Fig. 13—CAST ALUMINIUM BRONZE

was then drawn on each plate at the place where the pointers rested; small increments of load were then put on, and each pointer carefully watched and the positions marked for the corresponding loads. It can be seen that should there be any tendency of the knife-edges not to move absolutely in synchronism due to even a small failure of one side of the specimen before the other, the beam would immediately set itself at some small angle, and consequently the pointers would record the movement and locate it. This arrangement would also give a fairly accurate stress strain diagram for any material tested, and some observations were taken on a specimen of yellow deal, from which the stress-

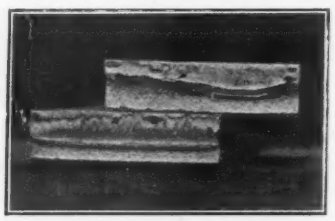


Fig. 14—ALUMINIUM ALLOY

strain curve—Fig. 7—was plotted. A specimen of mild steel bar tested with this gear on showed that the material remained perfectly steady up to half its maximum load, after which it began to shear, the movement of the knife-edges being regular for successive increments of load until fracture took place. In all the experiments this arrangement showed that there was no tendency for one side to fail before the other, the shear being apparently simultaneous over the whole area.

All the results obtained in these experiments seem to point to the fact that there is no common law connecting the ultimate shearing stress with the ultimate tensile stress, the ratio $\frac{F_s}{F_t}$ varying greatly with different materials. The test figures from the crystalline materials, such as cast iron or those with very little or no elongation, seem to indicate that the ultimate shear stress exceeds the ultimate tensile stress by as much as 20 or 25 per cent., while from the fibrous materials, or, more properly speaking, those with a fairly high measure of ductility, the ultimate shear stress may be anything from 0 to 50 per cent. less than the ultimate tensile stress.

TABLE II.—*Tests of Wood in Shear and Tension.*

Kind of wood.	Weight of cubic foot.	Ultimate tensile stress.		Across grain crippling load.	Ultimate shear stress. Across grain.	Ultimate shear stress. Along grain.	Percentage crippling load across grain of ultimate tensile stress.	Percentage ultimate shear stress across grain of ultimate tensile stress.	Percentage ultimate shear stress along grain of ultimate tensile stress.	Percentage of moisture.
	Lb.	Lb. per sq. in.	Tons per sq. in.	Lb. per sq. in.	Lb. per sq. in.	Lb. per sq. in.				
Pine .. .	39·5	9,467	4·09	1930	4872	470	21·0	53·0	5·12	15·7
Oak	47·7	15,963	7·14	Apparently none	5292	591	—	33·0	5·5	12·6
Deal	26·46	7,834	3·49	1195	2668	442	15·2	34·0	5·6	10·6
Teak	45·0	9,807	4·37	2764	3960	1022	28·2	40·4	10·4	10·0

A curve was drawn—Fig. 6—showing the variation of elongation percentage with the ratio $\frac{F_s}{F_t}$, and from this it can be seen that there is a certain amount of uniformity in the results. When the ratio $\frac{F_s}{F_t}$ is close to the 60 per cent., the elongation in every case shows very little variation from 10 per cent. Below, and above the 60 per cent. ratio, the elongation increases, that at 50 per cent. ratio being almost equal to that at 70 per cent., while from the 70 per cent. ratio upwards the variation is

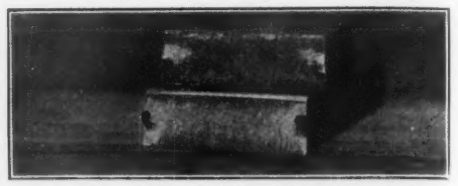


Fig. 15—DELTA METAL

inclined to be regular, the elongation decreasing as the ratio $\frac{F_s}{F_t}$ becomes higher, until with a very small or practically no elongation the ratio might be expected to reach 120 per cent. or 130 per cent.—that is, that the ultimate shear stress would exceed the ultimate tensile stress by 20 or 30 per cent. Further experiments might throw more light on this subject, and the author regrets that he was unable to extend the series of tests to embrace a wider, and, consequently, more interesting field. All the results obtained are shown plotted to a base of materials in Figs. 2, 3, and 5. Curves, sketches of apparatus used, and also a

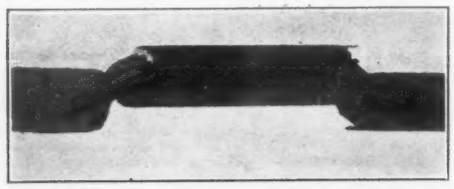


Fig. 16—TEAK ACROSS GRAIN

series of photographs of fractures of test pieces, &c., are appended. They are tabulated under the different headings in order to give a better reference for any details; and to those who are interested in the subject of strength of materials, they, together with the samples shown, will do more to shed a small light on the subject than any remarks by the author. In conclusion, the author wishes to thank Professor T. Hudson Beare for the great interest he has at all times taken in the experiments, and also the undermentioned firms for the extreme courtesy and kindness which they have shown in supplying material for the experiments, and in providing information and data for use with the tests:—The British Aluminium Company, the Delta Metal Company, the Phosphor Bronze Company, the

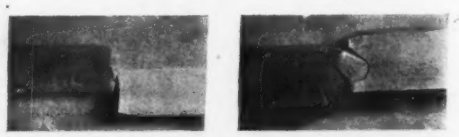


Fig. 17—PHOSPHOR BRONZE, ORDINARY AND SPECIAL

Leeds Forge Company, and Messrs. Willans and Robinson. The author wishes also to express his thanks to Mr. E. M. Eden, of University College, who kindly carried out a second series of shear tests on the specially treated alloys.

NAVAL ENGINEER APPOINTMENTS.

THE following appointments have been made at the Admiralty:—

Engineer Commanders:—George E. Bench, to the Pembroke, additional, for instruction of engine-room ratings in the Gossamer, vice Gaisford; Samuel Ashton, to the Vernon and Excellent, lent, for torpedo and hydraulic courses.

Engineer Lieutenants:—Ebenezer J. Allen, to the President, for service at the Admiralty, vice Barter; Frederick Barter, to the President, to assist engineer-overseer at Messrs. Parson's; David Black, to the Widgeon, vice Rock; Carl B. F. Le W. Rock, to the Hogue, vice Limpenny; Walter S. Damant, John B. Barrett, Hubert Goold, Edwin Cole, and Sydney M. G. Bryer, all to the Vernon and Excellent, lent, for torpedo hydraulic courses.

Engineer Sub-lieutenants:—Peter M. Samson, Russell O. L. Bond, Percy Reeve, Wellington B. Hume, Edward J. O'B. Croker, Herbert E. Hooppell, Joseph W. Baguley, Frank S. Carlisle, and Harold H. Huxham, all to the Vernon and Excellent, lent, for torpedo and hydraulic courses.

Chief Artificer Engineer:—Arthur Sandy, to the Vernon and Excellent, lent, for torpedo and hydraulic courses.

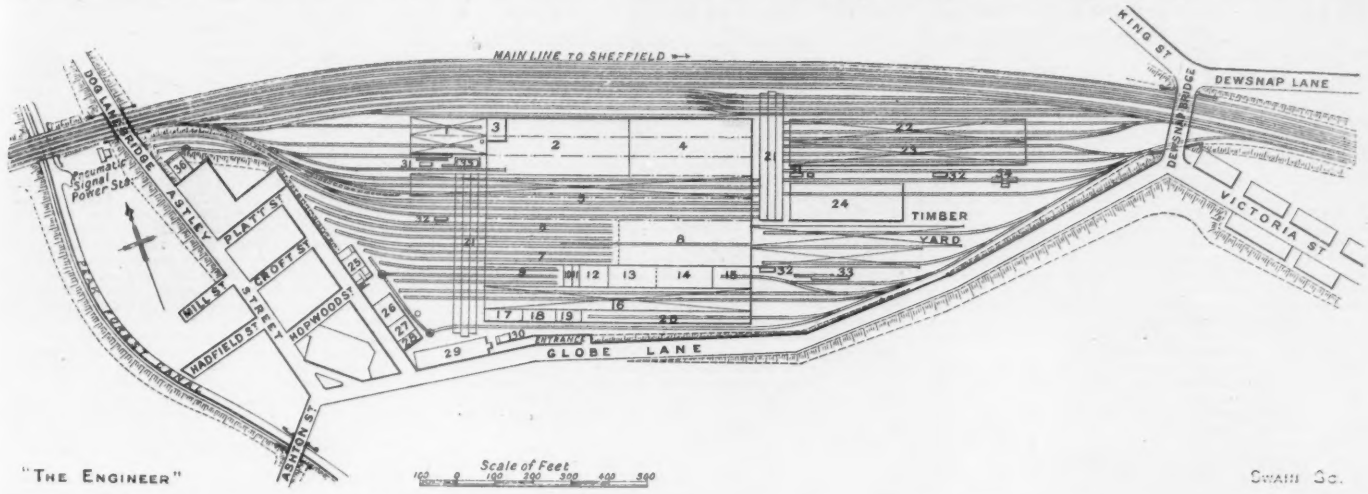
Artificer Engineers:—Alfred C. Nurse, Edward Richards, Charles S. Marks, and Frederick J. Randall, all to the Vernon and Excellent, lent, for torpedo and hydraulic courses.

Acting Artificer Engineers:—John M. C. Lucas, Thomas A. Cuthbertson, Walter E. Owens, and Ernest Murdock, all to the Vernon and Excellent, lent, for torpedo and hydraulic courses.

OBITUARY.

WE regret to have to announce the sudden death, on Saturday last, of Mr. Charles R. Bellamy, general manager of the Liverpool Corporation tramways and city lighting engineer. On December 12th Mr. Bellamy, in trying to avoid stepping upon a rope lying on some steps leading into the basement of his house, fell, spraining his ankle and injuring the calf of his leg. He kept to his room, and seemed to be progressing satisfactorily, but suddenly collapsed on Saturday night. A post-mortem examination showed that death was due to the clotting of an artery from the heart to the lungs, accelerated by the injury to the leg.

NEW CARRIAGE AND WAGON WORKS, GREAT CENTRAL RAILWAY



NEW CARRIAGE AND WAGON SHOPS OF THE GREAT CENTRAL RAILWAY.

THE time has at length arrived when, owing to the extension of the Great Central Company's lines of railway, and consequent augmentation of rolling stock, the company should provide increased facilities for repairs and replacements. In common with all other large railways, this company has for very many years had large workshops, those of the Great Central being at Gorton; but the site there, although surrounded by fields when the place was first laid out, is now bounded on all sides by streets and properties more or less valuable, which render impossible a further extension of the shops on the present site, excepting at such a cost as would be entirely inconsistent with the advantage to be gained. The directors have therefore decided to erect entirely new carriage and wagon workshops on a spot of land obtained for the purpose some time ago. This land forms part of the Dukinfield Estate, and lies between the company's Guide Bridge and Hyde Junction Stations, and is distant from the present Gorton shops between three and four miles. A contract has just been placed with Messrs. Craven Bros., Limited, of Manchester—who are acting in conjunction with Messrs. Markham and Co., Limited, of Chesterfield, in this matter—for the erection of these new premises, and when they are completed the carriage and wagon work will be transferred from Gorton to that place.

The new buildings will be of a substantial character, and will embrace the latest ideas in design and equipment; they will afford the fullest facilities for dealing not only with the ordinary repairs, but also for renewal of both carriages and wagons as such becomes necessary. The latest inventions in the way of hydraulic, pneumatic, and electric plants will be installed, in addition to the necessary steam appliances, together with labour-saving machinery—of course, with the idea of carrying out the work not only with rapidity, but also with due regard to economical production. The accompanying sketch conveys a general idea of the proposed arrangement of the buildings and their general dimensions.

The iron store, 200ft. by 100ft., is numbered 1 in the diagram; the forge and smithy, 375ft. by 150ft., is numbered 2. No. 4 shows the iron machine shop, 325ft. by 150ft.; whilst 5, 6, and 7 are devoted to the building and repairing of coaches and wagons, the greatest length being 700ft. The other principal shops are No. 16—underframes—also 700ft. long; Nos. 22 and 23, carriage repairing and lifting shops, both 620ft. long; and the timber shed—No. 24—300ft. long. Nos. 21 are surface traversers. The general offices are numbered 25, and cover an area of 100ft. by 50ft. An interesting feature is the mess-room—No. 29—which is no less than 200ft. long by 50ft. wide.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

BUSINESS has been practically suspended during this week in the engineering, iron and steel, and general trades, and the break in active operations has been welcome, since a good deal of pressure has lately been experienced in order to cope with the amount of work on the books. When operations are again resumed there will be plenty to get on with, since inquiries on foreign and colonial account continue plentiful, whilst home requirements are also considerable.

The Christmas holidays have been a very satisfactory time both for employers and workpeople in Staffordshire manufacturing industries. For some months past there has been regular employment, and the orders in hand in many cases amount to quite a considerable quantity of work. The way in which the demand from the leading foreign and colonial markets is keeping up is one of the chief elements in the prevailing business contentment both in the iron and steel trades, and also in the engineering trades, and manufacturers are glad to see the steady manner in which the foreign demand has of late increased.

Railway extensions in South America have caused a large demand for all classes of railway material, and it is expected that this will continue. The Indian demand keeps up well, Australia is improving, and South Africa is beginning to recover. With regard to prices, there has, of course, this week been no business whereby to test them, but they are understood to continue firm, and when transactions are resumed in a day or two, the market will probably be again found to be in favour of producers, particularly in the galvanised iron trade, where the recent 2s. 6d. rise brings the minimum quotation for galvanised corrugated doubles up to £12 2s. 6d. The call for foundry pig iron and also for forge sorts is persistent. Stock-taking and repairs have been in progress during the past week at several of the works.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Since last week the time has been practically monopolised by the holidays, and although the engineering and kindred trades have recommenced work there is little or no change to note. Prices of pig iron are well maintained, and it is a matter for great gratification that the Wigan Coal and Iron Company is with the New Year beginning again to make its "Kirkless Hall" brand of pig iron. There is no change in finished iron or steel. Manufactured copper is in some cases slightly dearer.

Barrow.—The demand for hematite iron is well maintained, and prices are alike firmer and higher. Mixed Bessemer numbers are at 71s. 6d. per ton net f.o.b., and some of the best brands fetch 72s. Warrant iron is quoted at 72s. a month net cash sellers, buyers 3d. less. Orders are well held throughout the district, and makers recognise now that they have practically reached the limit of their maximum output. It may be possible to put one or two additional furnaces in blast, but not more until more blowing power is available. The furnaces now in blast practically exhaust all the blowing power at one time employed in a larger number of furnaces, but the make of iron is now not only greater per unit of production, but is greater in the aggregate than at any time in the previous history of the trade. Anticipations of a fuller demand for iron are reasonably indulged in, on the ground that at present the iron produced is being used to the extent of 80 per cent., at least, in the shipbuilding material trade, while only 20 per cent. is being utilised in the Bessemer steel trade. The conditions are usually the reverse, and the probability is that early next year the demand on Bessemer steel makers' account will revert to its normal condition.

A very good business is being done in native sorts of hematite ore, and it is probable a further increase in output will soon be brought about. The greatest activity is at the Ronhead and Hodbarrow mines, where wealthy deposits of ore have been proved over a great area, and embracing many millions of tons of metal. Yet the smelters of the district are importing largely of Spanish and other foreign ores, which are selling at about 19s. delivered at West Coast ports, as against 15s., the current value of good native sorts. The large stocks of ore which some time ago existed at many of the iron mines in the district have been cleared away.

The position of the steel trade is unchanged. There is a brisk demand for shipbuilding material, but a poor trade in steel rails, billets, tin bars, hoops, and merchant sorts generally. The price of plates has gone up to £7 10s. per ton net f.o.b., and of boiler plates to £8 15s. Light plates and sheets are in brisk demand. Rails of heavy sections are at £5 17s. 6d., and although buyers are chary of giving this price, they are known to be in want of very big deliveries.

Engineers are busy, and have a brisk outlook for the new year. Boilermakers, ironfounders, and steelfounders are all busy.

Coal and coke are in good demand; prices are firm and high.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THIS has been largely a holiday week. In some quarters work ceased on the night of the 22nd inst., and on the following day the stoppage was general. Several firms utilise the season for stock-taking, and it is, in the main, a time for repairs and renewals wherever required. In one or two departments work was resumed on the 28th inst. A week's "play" is the usual rule at Christmas, and it was observed where practicable, but owing to the exceptional pressure which marked the closing quarter of the year, more especially towards the end, the holidays had in several instances to be abbreviated. The workers in the great establishments at the East End, and those engaged in the allied trades, have had much better times this season than they experienced twelve months ago. The revival of business has been general in iron and steel and in the heavy industries all round; but it has not extended to the lighter crafts which form so prominent a feature of Sheffield work, nor is there much prospect of these branches being much busier in the immediate future.

The iron trade during the year now closing has presented interesting features. At the commencement the outlook was most hopeful, and prices tended upward during the opening months. Then came a slight check in midsummer, but it was only of temporary duration, and the close of the year finds prices higher than they have ruled for five years. In December, 1904, West Coast hematites were at 66s. per ton, and East Coast at 61s. per ton. On March 31st, 1905, West Coast had advanced to 67s. 6d., and East Coast to 63s. On June 30th West Coast had receded to 64s. 6d., but East Coast were at 64s., or 1s. per ton more than at the end of the opening quarter. December values show West Coast hematites at 82s., and East Coast at 80s. These prices, high as they are, are not equal to those obtained in 1900, when West Coast hematites were at 90s., and East Coast at 85s. per ton.

In Lincolnshire irons forge, No. 4, was quoted in December, 1904, at 48s. 6d. per ton, and foundry, No. 3, at 50s. 6d. On March 31st, 1905, Lincolnshire forge, No. 4, was at 46s. 6d., and foundry, No. 3, at 49s. 6d. On June 30th forge weakened to 43s. 6d. and foundry to 48s. 6d., but December finds forge firm at 53s. 6d., and foundry at 56s. There has been an excellent trade in Derbyshire irons during the year, forge at the close being quoted at 51s. to 52s., and foundry at 56s. to 57s. per ton.

The finished iron trade in November and December became very brisk, and makers were able to advance the price of bars to £7 per ton, thus establishing an increase of 15s. on the year. In the steel trade the improvement was earlier manifested, and even more noteworthy. It was not until October, however, that values advanced to any extent in Bessemer billets. At the close of 1904 the price was £6 10s.; in April the quotation was £6 10s. to £6 15s., but in October £7 5s. was reached, and now the figure is £7 15s, Siemens billets, 10s., higher throughout. The advances slightly affected the free placing of orders, but the check was only temporary, and business has since been very satisfactory, makers being, as a rule, well booked ahead.

With the exception of armour-plates, the military material trade has been fairly satisfactory during 1905. The work in armour placed with Sheffield manufacturers this year was for three battleships and three cruisers. The battleships were the Lord Nelson, Agamemnon, and Dreadnought, built or building respectively at Jarrow, Govan, and Portsmouth. For the first, the Admiralty have ordered the side, bulkhead, barbette, citadel, bow protection, and deck plates; for the second, the gun shields; for the third, the side armour and conning and signal towers. The cruisers were the Natal, Defence, and Shannon, built or building at Barrow, Pembroke, and Chatham. For the first, the orders are for barbettes and gun shields; for the second, the gun shields; for the third, side armour, gun shields, and deck plating. A good deal of Government work in guns, forgings, and projectiles, has been placed in Sheffield during the twelve months. The expectation of orders for armour-plates on foreign account has not been realised, nor, so far as can be seen, is there any likelihood at present of such work coming forward.

In the railway, machine, and engineering departments there has been distinct improvement during the year. The British railway companies, though they have not abandoned their practice of ordering to meet immediate requirements, have recently been giving out work more freely, and, in some instances, in greater volume. The principal foreign customer during the year has been the Japanese Government, whose demands have been chiefly in wheels, tires, axles, springs, buffers, and other accessories of rolling stock. The wagon builders have had considerably more to do, with good prospects of increased work early in the New Year. Forgings and castings for marine purposes have been an increasing business since the beginning of 1905, and these are likely to be still more freely required in the early part of 1906. The principal engineering houses have done well, more especially in the latter part of the year, and the very satisfactory feature of their business is that it has been largely called for by extension of machinery and plant in the local works.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE holidays have limited buying this week, but there is no mistaking the fact that there is a more confident tone abroad, which augurs well for the progress of trade next year. Traders have not had an unsatisfactory experience in the year which is closing, but there is good reason for the belief that 1906 will show further substantial improvement in prices as well as in production and consumption. This year the revival has been more in demand than in values, and has been more in steel than in iron. In most branches prices moved very little during the first eight months of the year.

All the year the market for Cleveland pig iron has been disorganised by the continued heavy increase in the stock of Cleveland iron in Connal's public warrant stores. Never have stocks in this district accumulated at such a rate, or anything like it, and never has there been such an enormous stock in the warrant stores of this district. In the summer of last year 78,000 tons of Cleveland iron were held by Connal's, by the close of 1904 there has been a rise to 191,827 tons, and at the end of this year the quantity is over 700,000 tons, there having thus been an increase of half a million tons in the last twelve months. The increase has been very persistent; never was there a day on which a decrease could be reported, except on 19th and 20th of this month, on each of which days the stock was lessened by a few hundred tons, and that had the effect of strengthening the market. There is no doubt that if the producers of Cleveland iron had not been making too much iron they would have realised a higher range of prices than has been paid, just as the ironmasters who turn out hematite have, because they have no stock at all.

There is general expectation, however, that the consumption of Cleveland iron will be larger next year than it has been this, for more of it will be needed for steel-making purposes.

The amount of business done this week in Cleveland iron has been small, but not much was expected. Very seldom do prices move in Christmas week, but they are better this week than they were last week, owing to the brisker inquiry that was reported towards the close of last week. A considerable proportion of the inquiry was from America, and it was not only for pig iron, but also for semi-manufactured steel, such as billets. It does not appear that any business has resulted from these inquiries. The bulk of the business in Cleveland warrants is done by London speculators, operators here and at Glasgow being very quiet. The price this week has been 53s. 10½d. cash buyers per ton, the best figure this year having been 55s., and the worst 45s. 3d. For No. 3 Cleveland G.M.B. pig iron the price has risen to 53s. 9d. per ton for early f.o.b. delivery, and 54s. 3d. for over next quarter. No. 4 foundry is at 52s., No. 4 forge 51s. 6d., mottled 51s., and white 50s. 6d.

Hematite pig iron makers continue very well situated though they have not sold much of late. But that is not of much moment, as they have orders which will take up all they can produce for several months, and consumers of hematite always buy in large lots at a time, and then wait. The hematite market in this district has been strengthened by the reports that the German makers had advanced their prices 5s. per ton, but it turns out that they have not done so, though they have discussed it. However, makers in this district have kept the price of mixed numbers up to 70s. 6d. per ton, and No. 4 to 65s. Rubio ore is at 20s. 6d. per ton, delivered at Middlesbrough.

The stock of Cleveland pig iron in Connal's public stores has got to over 700,000 tons, the quantity reported on the 27th being 701,482 tons, an increase for December of 32,840 tons. The stock

consisted of 643,664 tons of No. 3 quality, 57,168 tons of other iron deliverable as standard, and 650 tons not deliverable as standard. It is reported that the Great Central Railway Company is about to establish pig iron warrant stores at Grimsby for Lincolnshire iron, similar to those of the North-Eastern Railway Company at Middlesbrough.

The exports of pig iron from the Cleveland district have been reduced by the holidays, but still are better than expected. Up to last Wednesday night they reached 75,615 tons, as compared with 73,713 tons last month; 63,545 tons in December last year; and 65,955 tons in December, 1903, all to 27th.

It is several years since the manufacturers of finished iron and steel in this district closed a year in such a satisfactory position, and on that account they are making the holidays as short as possible, more especially the rail and plate manufacturers. The tendency of prices in all branches is upwards, and it is not easy to place orders for execution next quarter. Heavy teel rails are not under £5 net f.o.b. Steel ship plate makers will not do business under £7, less 2½ per cent., and steel ship angles under £6 12s. 6d., less 2½ per cent. Steel sheets, black, are at £7 17s. 6d. for singles, and £8 2s. 6d. for doubles, and galvanised sheets have likewise been raised, producers in this district quoting and realising £12 15s. for 24-gauge in bundles—the minimum allowed by the syndicate for these last is £12 2s. 6d. Sheet prices have improved more than any others this year. Bar manufacturers are well sold ahead, and for iron bars not less than £7, less 2½ per cent., will be accepted.

The shipbuilding industry continues very brisk and likely to be so for the greater part of next year. For it 1905 has been the year of greatest production; in fact, the tonnage launched considerably exceeds that of 1900, which was the previous best year. At the North-Eastern ports 965,000 tons have been launched, or 235,000 tons more than in 1904. Altogether on the Tyne 357,446 tons were launched; on the Wear, 323,993 tons; on the Tees, 143,705 tons; at the Hartlepools, 128,898 tons; and at Blyth, 11,806 tons.

The marine engineering industry in the North of England has been active all the year, almost all the firms turning out more work than in 1904, the revival in shipbuilding having improved their positions. Messrs. Richardsons, Westgarth and Co. take the first place with 124,350 indicated horse-power, the North-Eastern Marine Engineering Company comes second with 104,905. The first named engined 41 vessels, and the second 57. The following is a list of marine engineering firms which in 1905 have turned out more than 10,000 indicated horse-power, and comparing the return with that of the previous year:—

	1905. I.H.P.		1904. I.H.P.
Richardsons, Westgarth and Co.	124,350	..	92,900
North-Eastern Marine Engineering Company	104,905	..	105,385
Wallsend Slipway and Engineering Company	90,860	..	50,400
George Clark, Limited, Sunderland	53,650	..	36,000
Parsons Steam Turbine Company, Wallsend	50,600	..	45,200
Central Marine Engineering Company, Hartlepools	34,190	..	31,550
W. Doxford and Sons, Sunderland	34,050	..	21,600
W. Gray and Co., West Hartlepool	33,650	..	29,000
Jno. Dickinson and Sons, Sunderland	31,656	..	43,860
Hawthorn, Leslie and Co.	25,425	..	76,500
Palmers' Shipbuilding and Iron Company, Jarrow	20,800	..	39,500

The coal trade is more favourable for the sellers than it has been for some months, and the revival that has taken place in the iron and steel industries now appears to have a good influence on the demand for and prices of fuel. The latter are tending upwards, and holidays are as short as possible. Steam coal has gone up to 9s. per ton f.o.b., and Durham gas coals have risen to 9s. 3d. f.o.b. Coke prices have likewise advanced, and 17s. 6d. per ton is generally quoted for medium qualities delivered at the furnaces on Teesside over the next half year.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron market was closed from Friday till Tuesday, owing to the holidays, and there is not, at present, much disposition to do business. The New Year holidays will be entered upon immediately, and the iron and steel works will be closed for about a week. Speculative transactions in warrants have been comparatively few and unimportant.

Business reports for the year are now being prepared and issued, and, so far as the nature of these has transpired, they seem to indicate that in most branches of trade a very large, if not a record business has been done during the closing year. The prospects, at least for the early part of 1906, are generally encouraging.

The output of pig iron in Scotland so far has been maintained without interruption. There are 91 furnaces in blast, compared with 85 at this time last year, and of the total 48 are making hematite, 37 ordinary, and 6 basic iron. The total output of the furnaces for the year will be ascertained in the course of the next few days, as will also the amount of iron held in the makers' private yards, as well as other important statistics of the trade.

The prices of Scotch makers' pig iron are steady. G.M.B., No. 1, is quoted at Glasgow 62s.; No. 3, 59s.; Carnbroe, No. 1, 65s.; No. 3, 62s.; Clyde and Calder, Nos. 1, 67s. 6d.; Nos. 3, 62s. 6d.; Gartsherrie, No. 1, 68s.; No. 3, 63s.; Summerlee and Langloan Nos. 1, 70s.; Nos. 3, 65s.; Coltness, No. 1, 76s.; No. 3, 66s.; Glengarnock, at Ardrossan, No. 1, 68s.; No. 3, 63s.; Eglinton at Ardrossan or Troon, No. 1, 62s. 6d.; No. 3, 60s.; Dalmellington at Ayr, No. 1, 65s.; No. 3, 60s.; Shotts at Leith, No. 1, 67s. 6d.; No. 3, 62s.; Carron at Grangemouth, No. 1, 70s.; No. 3, 65s. per ton.

The shipments of pig iron from Scottish ports in the past week were comparatively small, amounting to only 3815 tons, compared with 6753 in the corresponding week, showing a decrease of 2940 tons. The total shipments for the year to date are 289,269 tons, being 21,265 tons more than in 1904.

The arrivals of Middlesbrough pigs at Grangemouth for the past week were 10,087 tons, being 1307 tons more than in the corresponding week, and the total imports are now 484,306 tons, being 3031 tons more than last year.

The finished iron and steel trades have up till the time of writing been very busy, but they are now closing down for the New Year holidays, and little business will be done during the next week or ten days. These trades have been very busy during the last three months, and the outlook, especially in the steel trade, is very cheering.

The Corporation of Glasgow have entered into contracts for greatly extending their supplies of electric power, and they have placed large orders for generators of the newest construction, as well as for a considerable number of additional boilers.

Messrs. Beardmore, of Glasgow, who recently took over the Mossend Iron and Steel Works, have been making good progress with the arrangements for re-opening these works, and it is expected that they will be in a position to turn out shipbuilding and other material in the course of a few weeks.

A number of fresh shipbuilding orders are reported to have been placed, including a steamer which is to be built by Messrs. Murdoch and Murray, Port Glasgow, for passenger and cargo service on the river Amazon.

The agents in Glasgow of the Anglo-American Oil Company have intimated a further advance of £1 per ton in the price of machinery and engine oil.

There has been considerable activity during the last few days in the coal trade. The shipping department has been very active, and as many vessels as possible have been cleared in view of the New Year holidays. The aggregate shipments from the Scottish ports are 20,000 tons better than in the preceding week, and fully 50,000 tons over those of the corresponding week of last year. Another week's shipments have still to be added before the statistics are finished for the year; but it seems apparent that there will be an increase of at least half a million tons on the year's shipments compared with those of 1904. There is practically no change this week in prices of coal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

LAST week witnessed a most acceptable improvement in the condition of the coal trade generally. While Cardiff on one or two days recorded a clearance of from 60,000 to 70,000 tons, Newport indicated at the week-end a total despatch of 110,000 tons, 92,642 tons going to foreign destinations. Coastwise trade is yet somewhat slack. Swansea total despatch was also large—74,000 tons—and patent fuel nearly 19,000. Port Talbot despatched 22,611 tons to foreign destinations—a substantial proof of the progress this port is making.

In the Cardiff district small steam coals have not only maintained the firmness which has continued so long, but higher prices have been realised, and some cargoes have been sold for as much as 9s. 6d. per ton. Another class of No. 2 Rhondda is in strong demand for bunkering purposes, and for this 10s. 3d. has been paid, though quotations range from 10s.

Business on 'Change, Cardiff, has been principally confined to urgent matters, a holiday aspect continuing up to the middle of the week. Very little resumption of work at the collieries was made up to Wednesday, with the result that the great accumulations of coal on sidings at collieries and port have begun to show visible signs of decrease, and some of the hopeful among the coalowners already begin to anticipate a scarcity. House coal prices are generally about 3d. better, and at last some signs of improvement are being shown in the semi-bituminous trade of Swansea. This is noticeable at Clydach, Llamsamlet, and other quarters.

Tuesday was a very blank day at the Cardiff ports, only a few arrivals coming in, most of them light, with one or two cargoes of pitwood and one of iron ore. Mid-week no quotations were issued, but it was understood that practically no change had taken place from Saturday, excepting that the last issued list must be taken as firm, and, in view of scarcity, strong likelihood of increased prices for best steam and smalls. I give latest prices:—Best steam, 12s. 9d. to 13s.; best seconds, 12s. to 12s. 6d.; seconds, 11s. 6d. to 11s. 7½d.; drys, 11s. 3d. to 11s. 9d.; very best smalls, 9s. 3d. to 9s. 6d.; best ordinaries, 8s. 6d. to 8s. 9d.; seconds, 7s. 9d. to 8s.; inferiors, from 7s. 3d. to 7s. 6d.; best Monmouthshire semi-bituminous, 11s. 9d. to 12s.; best ordinaries, 11s. to 11s. 6d.; seconds, 10s. 9d. to 11s; best bituminous households, 16s. to 16s. 3d.; best ordinaries, 13s. 6d. to 15s.; seconds and other kinds, 10s. 6d. to 11s.; No. 3 Rhondda, 13s. 6d. to 13s. 9d.; brush, 11s. 6d. to 11s. 9d.; small, 9s. 9d.; No. 2 Rhondda, 10s. to 10s. 3d.; through, 8s. 6d. to 8s. 9d.; small, 7s. 6d. to 7s. 9d. Patent fuel, 13s. 3d. to 13s. 6d. Coke, furnace, 16s. 6d. to 17s.; foundry, 18s. 6d. to 22s. Pitwood, 19s. 3d. to 19s. 6d.

At Swansea coal prices have been well maintained. France continues to take the largest cargoes, and last week imported nearly 30,000 tons. Italy was a good second, with 12,000 tons, and Germany third, with 6552 tons. It is noteworthy that Sweden, Algeria, and Holland are large customers. In patent fuel the character of the trade is shown by the despatch last week of 3280 tons to France, 7160 to Italy, and 6050 to Algeria.

Last quotation list, Swansea, indicated the same firmness in steam as shown by Cardiff: best, 12s. 6d. to 13s; seconds, 10s. to 10s. 6d.; bunkers, 9s. 6d. to 10s.; small, 6s. to 7s.; No. 3 Rhondda, 13s. 6d. to 14s.; through, 10s. to 10s. 6d.; small, 8s. to 9s. Patent fuel, 11s. 6d.

Best anthracite for malting remains at 19s.; seconds, 16s. to 17s.; big vein, 13s. 3d. to 13s. 9d.; red vein, 9s.; cobbles, 17s.; nuts, 17s. 6d. to 19s. 6d.; peas, 10s. 6d. to 11s.; rubbly culm, 4s. 3d. to 4s. 6d.; duff, 3s. to 3s. 6d. Exchange authorities give the idea that not only are coal prices firm, but that in some cases these prices have been exceeded.

During last week the industries of the Swansea Valley were very active. The make of steel was exceptionally good, and the produce of the tin-plate mills, totalling 61,915 boxes, implied a full drive, while no less than 124,325 boxes were stripped. Stocks now are little over a full week's export, namely, 131,562 boxes. A revival of business for the East and a resumption of the prostrate Russian trade would bring about a boom. One vessel is loading this week for the Far East; and Swansea Harbour, with 71 vessels in for loading, may be considered in a healthy condition. Last week exports were the largest on record, and showed an increase of 71,000 tons over the corresponding week. Some degree of weakness exists with regard to ternes and other finished plates, and business in the tin houses is restricted. Steady work has continued at the copper and spelter works; nickel is also in demand; tube-making brisk; and engineering sheds were busy up to the holidays. Next report of the holiday week must show a set back.

No quotations were given this week up to my despatch of steel bars, billets, or tin-plates. Spanish ore remains firm at 18s. to 18s. 6d. During the week a large cargo of steel billets came from Baltimore to the Melingriffith Tin-plate Company, Cardiff. Tone of the tin-plate market is good but quiet. Latest: Bessemer steel cokes, 13s. to 13s. 1½d. Liverpool, 12s. 9d. Wales, more doing in oil sizes.

I regret to note that the strikes at the Risca and Llanbilleth Collieries continue. A strong effort was made on Saturday to bring them to a termination, and in proof that the Conciliation Board are making strenuous efforts, Mr. H. P. Martin, Mr. Deakin, and Mr. Routledge were named by the owners, and Messrs. Onions, Brace, Hartshorn, Woodward, and Edwards by the men to arbitrate, Mr. Abraham M.P., and Mr. F. L. Davis aiding. Unfortunately after a long discussion the meeting was abortive. With regard to the late coal settlement two delicate points remain, which outsiders think may cause trouble; one is the case of small coal, the other the hauliers. The higher the price and firmer the demand for smalls, the more the discussion continues amongst the colliers, but it is hoped they will keep to their leaders, who have considered the various points very carefully, both in the interest of the coalowners and workmen.

Ireland continues to export tin-plate boxes freely to Wales.

In connection with the 1906 Bill of the Alexandra Dock Company, it has been shown that during the past five years the increase in receipts has been £25,000. The new Bill seeks powers to raise additional capital of £400,006, a proof that the promoters regard the great undeveloped tract of the Monmouthshire coalfield with hopefulness.

NOTES FROM GERMANY.

(From our own Correspondent.)

IN the different branches of the Rhenish-Westphalian iron industry business continues as before; no changes have to be reported in prices, and demand is as steady as ever. In the pig iron department an extensive inland and foreign consumption secures regular activity for weeks and even months ahead, both in the Siegerland and in Rheinland-Westphalia. Iron ore not being obtainable in sufficiently large quantities, there is some uneasiness felt as to a possible scarcity in pig iron during the next quarter.

A rise in quotations for the second quarter has been agreed upon, raw spathose ore being quoted M. 12·10 p.t., and roasted ditto M. 17 p.t. There is talk of an advance of several marks in the prices for raw iron in consequence of the raised quotations for iron ore. At a meeting of the Pig Iron Convention, which is to take place in a day or two, the new prices will be fixed. The Siegerland Pig Iron Convention is reported to have sold 7C00 t. spiegeleisen to America, to be delivered in the second quarter of 1906.

The semi-finished steel trade has developed and improved in a most satisfactory way, and export quotations are, in many instances, M. 20 p.t. higher than at this time last year. Unfortunately, the Steel Convention has reduced the export bounty for the Convention works, and for outsiders the said bounty has even been totally abolished. Scrap iron is firm, the demand remaining satisfactory, and quotations, consequently, are inclined to rise. In the bar trade both dealers and manufacturers try to realise better prices. Basic steel bars can hardly be bought at less than M. 115 p.t., and M. 117 p.t. has been asked and obtained in some cases. Iron bars, too, continue in good call; the mills are amply provided with work, and a rise in prices is pretty sure to take place later on. The hoop mills also have plenty of orders on their books and their present employment is active. Girders are, comparatively speaking, in good request, and the Steel Convention fixed the current price on M. 117 to M. 120 p.t.; export quotations are M. 20 p.t. lower. Heavy plates for shipbuilding and boiler-making purposes are in specially fair request; prices, both for plates and for sheets, are irregular. The trade in wire continues firm, which is chiefly due to the prolongation of the Wire Rod Convention. Now endeavours are being made to prolong the Wire Rail Convention as well.

Hardware sells freely, and is pretty well paid for.

Demand for coal is vigorous in Rheinland-Westphalia, and the pits experience much difficulty in satisfying their customers. Coal for coke making is in particularly good request.

Home and foreign inquiry remains extensive in the Silesian coal industry; Russia buys freely, and the gasworks and cokeries have also consumed heavy lots. A very favourable position prevails on the coke market, and production has been lower than consumption for some weeks past.

Business transactions on the Austro-Hungarian iron market are principally confined to sales for the first quarter in 1906, and these are not extensive, because consumers and producers are rather disinclined to do any larger trade until the syndicate question has been settled.

Negotiations are carried on for the purpose of forming a sheet convention, with but little result however.

Current list prices are:—Wikowitz forge pig No. 1, 102 crowns; grey charcoal pig iron, 108 to 110 crowns; hematite, 110 to 113 crowns; spiegeleisen, 10 to 12 per cent. grade, 135 to 140 crowns p.t. Vienna; Styrian bars, 210 to 220 crowns; boiler plates, 290 to 300 crowns; tank plates, 250 to 260 crowns; galvanised sheets, 450 crowns; girders, 222 crowns p.t.

Inquiries for engine fuel come in freely in Austria-Hungary, and the active business generally done in coal and coke cannot fail to influence prices. Hitherto much firmness was shown, but an allowance in quotations has not as yet taken place, probably because many consider the brisk demand at present experienced to be caused by a desire to be well provided with fuel in case of a strike, or passive resistance on the North Railway, rather than by a generally healthy condition of the market. To Roumania large shipments have recently been made. The trade in coke is very active, and consumers often find it difficult to obtain the supplies they need.

In Belgium raw iron is getting more scarce from week to week, and has been exceedingly firm in consequence. Manufactured iron sells freely, and at good prices. The endeavours to form a wire nail convention have been without result, but optimists hope that later on another and more successful attempt will be made.

The favourable position of the Belgian coal market before noted continued during the last week. An animated and brisk business is done in the French iron industry, and the coal trade, too, has shown a good deal of life.

ALMANACS, CALENDARS, &c.

AMONGST the later batch of almanacs is one issued by the *Chemical Trade Journal*. This is of the wall type, with large monthly tear-off sheets. The Electrical Power Storage Company, Limited, 4, Great Winchester-street, London, have sent us, with the compliments of the season, a combination blotting pad, almanac and diary, similar to those which they have distributed for several years, and which always proves a most acceptable form of advertisement. Messrs. Ashwell and Nesbit, Limited, 12, Great James-street, Bedford-row, London, have again produced a wall calendar of considerable artistic merit. The four figures shown typify "Hygiene," "Building," "Engineering," and "Chemistry." The dates are given on separate slips, and in very large type. Messrs. Henry Simon, Limited, Manchester, find no necessity to alter the block wall calendar which has long been deservedly popular on account of the well-chosen mottoes attached to each daily slip. The same remark applies to the calendar of Messrs. E. R. and F. Turner, Limited, of Ipswich. Mr. John Etherington, 39A, King William-street, London, has sent us a wall calendar of the monthly block pattern, but each monthly sheet also contains, in smaller type, the calendar for the whole of the year. Mr. E. Arnold Pochin's wall calendar is of the monthly block style, and some useful information is provided in connection with tooth gearing. We have received from the Dermatine Company, Limited, a neat little celluloid pocket-case for containing sticking plaster and stamps.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. D. G. SUTHERLAND, who for the last five years has held the post of chief engineer of Messrs. Bruce, Peebles and Co.'s contract department, resigns his position at the end of December to become a partner in the old-established firm of engineers, Messrs. Mitchell, Graham and Son, 46, Buccleuch-street, Edinburgh.

MR. W. C. POLLOCK informs us that he has retired from the firm of Pollock, Whyte, and Waddle, gas and oil engine makers, Johnstone, and has started business for himself under the name of Pollock and Co., at Star Works, Johnstone, N.B., where he intends building gas engines from 1½ to 80 brake horse-power, oil engines from 1 to 20 brake horse-power, and suction gas producers up to 250 brake horse-power. He is making a speciality of suction gas plants.

THE Straker Steam Vehicle Company, Limited, advises us that it has altered the name of the Straker Steam Vehicle Company, Limited, to that of Sidney Straker and Squire, Limited, and that the business of Straker and Squire has been incorporated with it, so that all future matters will be conducted under the new title. The company has left 9, Bush-lane, and is occupying No. 5, Nelson-square, Blackfriars-road, as temporary offices, pending the completion of its new administrative buildings, repair shops, and garage in Nelson-square, so that all communications from this date should be sent to Sidney Straker and Squire, Limited, Nelson-square, Blackfriars-road, London, S.E.

CONTRACTS.—The Rivet, Bolt, and Nut Company, Limited, of Glasgow, has secured the contract to supply the steel ship rivets required in his Majesty's dockyards at home and abroad. The company has undertaken, when required, to give a weekly supply of no less than 300 tons of rivets, and it is extending the capacity of its works in the North of England.—The Holwell Iron Company, Limited, of Asfordly, Melton Mowbray, and 28, Victoria-street, Westminster, has secured the contract for cast iron pipes, cylinders for pump wells, and fittings in connection with the Elton extension, Corporation Waterworks, for the city of Peterborough.

BRITISH PATENT SPECIFICATIONS.

Selected and Abridged by **JAMES D. ROOTS**, *M.I. Mech. E.*

When an invention is communicated from abroad the name and address of the Communicator is printed in italics.

When the abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent-Office Sale Branch, 25, Southampton-buildings, Chancery-lane, London, W.C., at 8d. each.

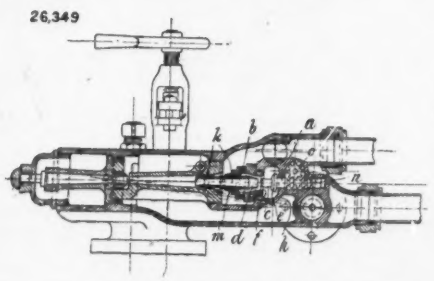
The first date given is the date of application; the second date at the end of the abridgment is the date of the advertisement of the acceptance of the complete specification.

Any person may on any of the grounds mentioned in the Acts, within two months of the date given at the end of the abridgment, give notice at the Patent-Office of opposition to the grant of a Patent.

STEAM ENGINES AND BOILERS.

26,349. December 3rd, 1904. — IMPROVEMENTS IN INJECTORS, James C. Metcalfe and Richard D. Metcalfe, Sheen Bank, Lord-street, Fallowfield, Lancashire.

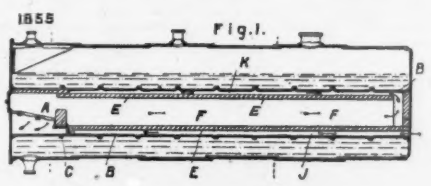
This invention relates to injectors, and the object is to improve certain details of construction. There are fifteen figures. Fig. 1. is a longitudinal section through an injector constructed according to this invention. The spindle *a* is co-axial with the main steam nozzle *b* of the injector, and has a cylindrical end portion *c* adapted to fit steam-tight into the inlet end *d* of the steam nozzle *b*. This extension *c* is formed with a flat end, but it may, if desired, be formed with a conical end so as to regulate the area of admission for steam to the steam nozzle and so increase the working range or lifting power. Behind this cylindrical portion of the spindle is a conical portion *e* adapted to act as a valve, and to make steam-tight contact with a seat *f* formed in a bush or hollow plug, which is screwed into the main casting of the injector. This valve *e*,



when closed, cuts off communication between the steam inlet passage *k* of the injector on the one hand, and, on the other hand, the interior of the main steam nozzle *b*, and also the annular space *k* between the steam nozzle *b* and the steam ejector cone *m*. When the valve *e* is moved off its seat only a short distance steam is admitted to the annular space *k* and so acts to draw up water to the injector. When the spindle *a* is moved so as to withdraw the valve from its seat the cylindrical portion *c* of the spindle is removed from the interior of the nozzle *b*, and steam is admitted to the interior of this nozzle, thus allowing the injector to work in its normal manner. The necessary motion is given to the spindle by forming on it a rack *n* adapted to engage with a pinion *o* mounted on a shaft which passes through the injector casing, and is provided outside the casing with a small wheel or with a handle. The rack *n* may have annular teeth as shown, and the spindle can be rotated on its own axis without interfering with the engagement of the rack with the pinion.—*November 29th*, 1905.

1855. January 31st, 1905.—IMPROVEMENTS IN OR RELATING TO THE FURNACES OF STEAM BOILERS OF THE LANCASHIRE, CORNISH, OR OTHER SIMILAR TYPE, Alfred Smallwood, 52, Gracechurch-street, London.

This invention relates to improvements in the means for generating and applying heat in steam boilers of the Lancashire, Cornish, or similar type. There are four figures. Fig. 1 is a longitudinal section through a Lancashire boiler. The grates or furnaces A are formed within or adjoining the front end of the furnace tubes B, and may be provided with a bridge C, beyond which an inner tube E of fire-brick, fire-clay, plumbago, or other suitable material is provided, and supported in a position at or near the centre of the furnace tube by means of a supporting division e^1 in such a manner that a space is provided between the inner tube and

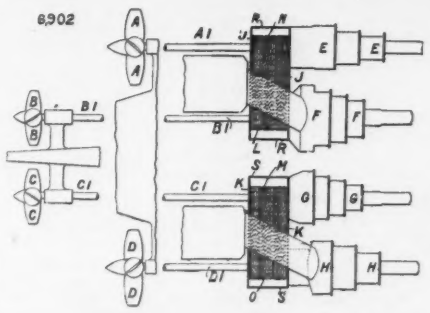


the boiler tube. In addition to the bottom or supporting division the space between the tubes is divided on each side, thus dividing the space into the three longitudinal flues J and K, the two lower ones each occupying a quarter of the circumference, while the top one K occupies the other half. The inner or fire-brick tube E communicates at the front end with the grate A, and forms the combustion chamber F, the rear end being connected with the top flue or chamber, by which means the heated gases ignited in the combustion chamber are first passed through the top flue K or chamber over the combustion chamber and back again under the combustion chamber by the bottom flues J, the top flue being connected with bottom flues J at the grate end of the furnace tube to enable the heated gases to take this course. By this arrangement the tube E forming the combustion chamber F is retained in a state of incandescence, by reason of the passage of the fully ignited gases, through the flues J and K, thus assisting to ignite the unconsumed gases in their passage through the combustion chamber, while at the same time the arrangement of the combustion chamber E with its surrounding heat chambers H J and K ensures a more perfect application of the heat to the boiler through the furnace tubes.—*November 29th*, 1905.

TURBINES.

6902. April 1st, 1905.—AN IMPROVED ARRANGEMENT OF TURBINE MACHINERY APPLICABLE FOR THE PROPULSION OF SHIPS, James Hamilton, Ardedynn, Crosloan-road, Kelvinside, Glasgow.

With such arrangements as hitherto constructed, the turbines have been usually directly coupled to and have driven the shafts passing through them. Consequently, when low speeds and correspondingly small powers are required—as is the case with war vessels during a very large proportion of the time they are under steam—it might be necessary to cut off the supply of steam to one or more of the turbines, thus stopping one or more of the propellers and causing a loss of efficiency due to the drag of that or those propellers. The object is the combination of ordinary turbines with what may be termed "two-way" turbines—that is, turbines in which both members rotate in opposite directions—in such a manner that while all the shafts and their propellers are driven at high or low speeds, the disadvantages in the matter of losses of efficiency due to dragging of stopped propellers at low speeds are overcome. There are two figures. Fig. 1 is a plan, showing the application of the invention to a ship driven by four propellers A B C D on a like number of parallel shafts A^1 B^1 C^1 D^1. The turbines E H driving the two outer shafts A^1 D^1 are of ordinary stationary-and-rotatory member type, one E being high pressure and the other H being low, while those F G driving the inner shafts B^1 C^1 are of the "two-way" type, the one G being high pressure and the other F low. Each inner shaft—B^1 and C^1—rotates reversely to the other shaft—A^1 and D^1—which is adjacent to it and carries a propeller of opposite hand. One member of each two-way turbine F G is connected to one of the inner shafts B^1 C^1, which passes through it, and the other member of each is cross-connected by

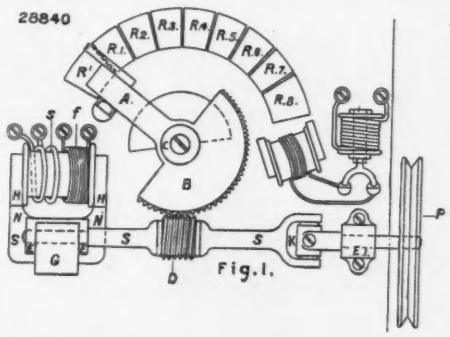


multiple pitch chains J K of the laminated toothed type engaging toothed wheels L M secured to the members and toothed wheels N O secured to the shafts A^1 D^1, to which the rotatory members of the ordinary turbines E H are connected. With this arrangement the outer member of an inner turbine—F or G—and an outer turbine—E or H—move synchronously and in the same direction with one another—that is to say, F with E and G with H—their shafts B^1 and A^1 and C^1 and D^1, however, rotating in opposite directions. These turbines are of the type designed to run at a comparatively low speed—say, 400 revolutions per minute. In order that these pitch chains may be preserved from undue wear and be effectively lubricated, they are completely enclosed in gear cases R S, to which graphite or like lubricant is supplied.—*November 29th*, 1905.

ELECTRICAL APPARATUS.

28,840. December 30th, 1904.—A SELF-ACTING ELECTRIC MOTOR-STARTING RHEOSTAT, John A. Hirst and Percy S. Brook, Northgate Electrical Engineering Works, Victoria-road, Chester.

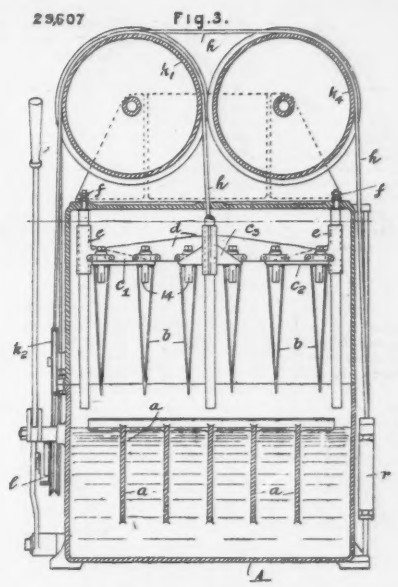
This is a self-acting electric motor-starting rheostat, operated from any distance, and more especially intended to enable starting resistance to be automatically cut gradually out of an electric motor circuit, together with suitable means for instantly re-inserting the resistance when no current is flowing or the circuit is broken. The object is to enable an electric motor to be safely started and stopped by the simple act of closing or opening a main switch in the supply circuit. There are three figures. Fig. 1 shows a plan of this self-acting rheostat mounted on an insulating base. On the centre-pin C, round which the contact arm A can rotate against the pressure of a coiled spring, is placed a flat worm-toothed metal segment B, and gearing into the segment is a worm D upon a horizontal spindle S. This spindle S is free to rotate in two specially-adapted bearings E and E^1, and when it is so rotated by a pulley P, the worm segment B is slowly turned round, and thus sweeps contacting arm A, to which it is attached, along over the contact studs



R^1, R^2. To enable the worm D to be thrown into and out of gear when required, the bearing E is arranged to work freely up or down in guides G, while the bearing E^1 is attached to the frame of the rheostat. The necessary flexibility of the spindle is provided by doubly hinging the spindle S by means of a universal joint K; or the fixed bearing E^1 may be mounted on a pin on the base-plate, so that it is free to oscillate, the spindle being then driven by a fork and disc and pin, or similar suitable means. In the normal position the end of the spindle S and its free bearing E are down, and the worm D therefore disengaged from the worm segment B, carrying the contacting arm A. The arm A is then on the first contact stud R, and has the usual coiled spring round C, tending to keep it back on the first stud R, the ohmic resistance of the rheostat being such that the starting current only then will flow. Just above the free-sliding bearing E is placed a compound-wound lifting magnet, having polar horns H, to attract a suitably-shaped iron armature N, forming part of the bearing E. The thick series wire winding *s* of this magnet is placed between contacts R and R^1, the whole being in series with the motor armature. The fine wire winding *f* is connected in series with the motor shunt windings. When the current is switched on, it passes through the motor armature coil *s* and shunt coil *f* of the magnet, energising its magnet core, which then attracts and lifts the armature N and bearing E, together with the spindle S and worm D, thus throwing the latter into mesh with the toothed segment B. The pulley P is driven by the motor axle, and, toothed segment B being now in mesh, the arm A at once begins to travel round against the pressure of the spring on its centre-pin C, and passing over contact studs R and R^1, &c. When arm A has passed beyond contact arm R^1, the series winding *s* of the magnet is out of circuit, but the magneto motive force of the shunt windings *f* continues to energise the magnet sufficiently to hold the armature N in place, and the arm A continues to travel over the studs and decrease the amount of resistance in the motor armature circuit.—*November 29th*, 1905.

29,607. December 31st, 1904.—IMPROVEMENTS IN LIQUID RESISTANCES FOR CONTROLLING THE CURRENT IN ELECTRO-MOTORS AND THE LIKE, Messrs. Bruce Peebles and Co., Limited, and Arthur C. Peebles, East Pilton, Edinburgh.

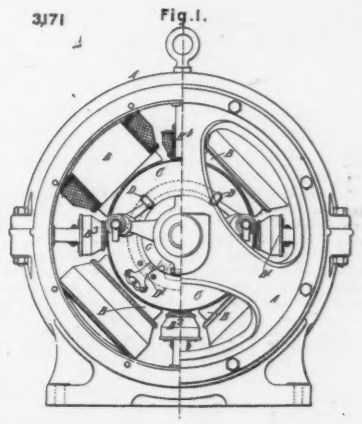
This invention relates to liquid resistances such as are suitable for use in starting electro-motors. It is especially suitable for induction motors in the respective phases of which such resistances are included. The invention is shown applied to a three-phase induction motor starter and controller. There are seven figures. Fig. 3 is a sectional elevation. A cast iron casing A is preferably divided horizontally into two parts. The lower part, which contains the liquid, has a series of transverse dividing plates *a*, which may be cast integral with or otherwise secured to the casing. These and the casing form the fixed electrode. The movable electrodes consist of wrought iron plates *b* detachably secured to light gun-metal frames c_1 c_2 c_3 c_x — which frames are adapted to be raised and lowered so that the wrought iron plates enter the liquid between the fixed cast iron dividing plates *a*, but without touching these. In the case of a three-phase motor there may be three of these frames or three sets of these frames, insulated from each other and from a supporting bracket *d*, to which they are all attached, through the plates *b*, and by means of which they are raised and lowered. The frames are provided with sleeves *e* adapted to slide on gun-metal rods, which serve as guides. In the case of a three-phase motor there may be three such rods insulated from the casing and from each other, and connected by



suitable terminals *f* to the respective phase circuits of the motor. One of the rods g_3 is duplicated at g_x; and, similarly, one of the frames c_3 is duplicated, thus dividing this circuit into two branches, so that there are four rods and four frames instead of three. To complete the circuit of the respective phases, the current passes from the respective guide-rods *g* through the sliding sleeves *e* to the gun-metal frames *c*, thence to the wrought iron plates *b*; then in multiple paths across the liquid to the dividing plates *a*, and so to the casing A and the neutral point, the value of the resistance depending upon the depth of immersion of the movable electrodes. Each gun-metal frame *c* is provided with a series of short-circuiting contacts 14, which, when the movable electrodes are in their lowest position, make good electrical contact with copper plates connected to the casing, thus cutting out the liquid resistance entirely. The raising and lowering of the movable electrodes is effected by means of a wire rope *k*, one end of which is attached to the supporting bracket *d*, the rope passing round grooved guide pulleys k_1 k_2 and driving pulley *l*, then round the further guide pulleys k_2 to a balance weight *r*, to which the other end of the rope is attached.—*November 29th*, 1905.

3171. February 15th, 1905.—IMPOVEMENTS IN AND RELATING TO ELECTRIC MOTORS AND DYNAMO ELECTRIC MACHINES, Messrs. Vickers, Sons and Maxim, Limited, and Alfred D. Williamson, River Don Works, Sheffield.

This invention relates to electric motors and dynamo electric machines, particularly electric motors of the kind in which the speed may be varied between wide limits by regulating the strength of the magnetic field in which the armature revolves. In such machines, although the armature strength does not vary under the variations of the strength of the magnetic field in changing the speed of the machine, provided the full load is maintained, the armature coils or turns,



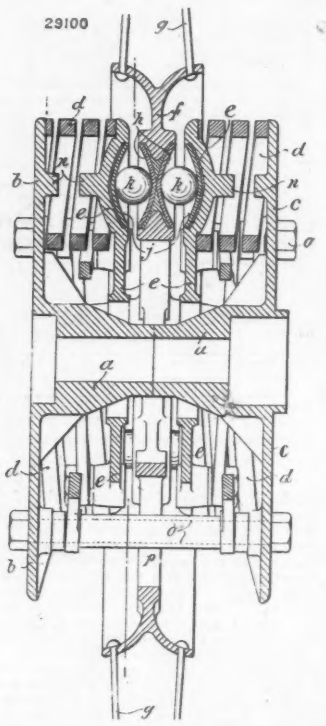
in which current is undergoing commutation, offer a higher reactance voltage as the speed of the armature increases. There are four figures. Fig. 1 is a sectional end view of a variable speed electric motor, provided with auxiliary poles, excited as described. A is the frame or casing which carries the field magnets B for producing the magnetic field in which the armature C rotates. D D are the main brushes, and D^1 is the auxiliary brush, suitably arranged to make contact with commutator *c* of the armature C. B^1 B^2 B^3 B^4 are the auxiliary magnetic poles, arranged between the main field magnets, and excited by a current produced by the difference of potential between one of the main brushes D and the auxiliary brush D^1. The current passes from the positive main through the windings of the field magnets B to the negative main. It also passes to the armature C, through the main brush D, whence it passes to the negative main through the other main brush D. The reversing field current passes from the brush D,

through the coils of the auxiliary poles B^1 B^2 B^3 B^4 to the auxiliary brush D^1. The auxiliary poles thus excited provide a reversing field resulting in the advantages hereinbefore stated. The energy required for the excitation of the windings of the auxiliary poles is in proportion to the reactance voltage, and is greatest when the speed is highest. This feature tends to maintain the efficiency of the machine at a constant value, as the auxiliary poles will consume less exciting energy at the lower speeds, at which times the field current is at its full strength.—*November 29th*, 1905.

MISCELLANEOUS.

29,100. December 30th, 1904. IMPROVEMENTS IN SPRING WHEELS FOR VEHICLES AND CYCLES, Percy J. Neate, Belsize, Watts-avenue, Rochester.

In this invention the movable rim of the wheel is coupled to the hub member through the medium of springs acting approximately parallel to the axis of the wheel. Cup-shaped recesses on each member kept apart by balls are so arranged that radial or rotational movement of either member relatively to the other in any direction in the plane of the wheel serves to stress all the wheels alike and so secure the required resiliency. There are twelve figures. Fig. 1 is a vertical section; *a* is the hub of the wheel, and *b* and *c* are the flanges suitably spaced apart; *d d* are coiled springs which press upon two cup-carrying plates *e e*, which are freely suspended between the flanges *b* and *c* and adapted to receive between them the rim flange *f*, which is connected to the



felloe of the wheel by suitable spokes *g* coupled to lateral flanges at the outer edges of the rim flange. Both the rim flange *f* and the freely suspended cup-carrying plates *e e* are fitted with cup-shaped recesses *h j*, which cups face one another, and on which the opposing faces of the cups roll when the rim member moves relatively to the hub member, and, owing to the cup-shaped formation of these recesses, any movement of the balls *k* away from the bottoms of the cups due to their relative displacement will cause the surfaces of the cups carried by the plates *e e* to be moved away from the cups carried by the rim flange *f* against the action of springs *d*, and conversely the tendency of the rim will always be to return to concentric position with regard to the hub when released from its load. Stops *n n* may be provided to limit the motion of the cups and the extent to which springs *d* can be compressed. It is of great importance to place the cup-and-ball connections at three points only on each side of the plane of the wheel. The opposite hub flanges *b c* are fitted as two parts of the hub coupled by through bolts *o*, around which suitable clearance apertures *p* will be provided in the rim flange *f* to give and yet limit the necessary freedom of motion between the members of the wheel.—*November 29th*, 1905.

PROJECTILES.

3921. February 24th, 1905.—IMPROVEMENTS IN ARMOUR-PIERCING PROJECTILES, William H. Harvey, 77, Mountholme-road, Wandsworth Common, London, S.W.

This invention relates to projectiles that are made tubular and with a removable back plug or cap that falls away when the projectile leaves the bore of the gun, so that the resistance to flight is decreased and its penetrating power increased. The object is to render the back plug or cap self-closing and self-tightening under pressure from the rear, and also to ensure that it shall be surely and automatically removed or opened after the projectile has left the gun. There are seven figures. Fig. 1 is a longitudinal section of an armour-piercing projectile constructed according to this invention, and an end view of the back plug or cap. Fig. 2 is a similar view showing a modified form of construction. A series of segments *a* are grouped together to form a hemisphere, cone, or pyramid, of which the apex points towards the rear of the projectile *b*. These segments *a*, which fit together very accurately, are lodged in the rear end of the hole *c* through the projectile, and are held in position by having their circumferential bases lodged in a channel or recess *d* in the tube and their outer edges bearing closely against the corresponding edges of the adjacent segments. These segments are so bevelled and hollowed and are so recessed in the hollow of the projectile that if the rest of the hole is left open the mere rush of the air through the projectile after it leaves the gun would be sufficient to throw them open and eject them entirely from the rear end of the shot, thus making the passage through the projectile quite clear. In regard to the segmental

3,921

Fig. 1.

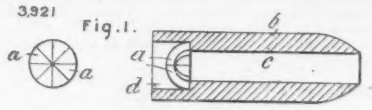
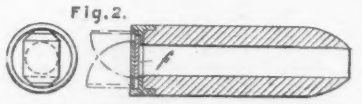


Fig. 2.



back plug the aim is to make a plug which can be readily removed by pressure from the front, but will withstand the greatest pressure from rear when the gun is fired, without tending to become wedged in the hollow of the shot, which wedging might disrupt the shot and cause it to jam in the bore of the gun. In the case of a tubular projectile—Fig. 2—fitted with a cap at the rear end, the cap itself contains a hole corresponding with the hole through the shot, and the hole in the cap is fitted with one or more flap valves *f* hinged to the cap and closing over the hole. These flap valves are easily opened by the rush of air through the projectile from front to back, but present a firm resistance to any force from the rear, such as that of the exploding powder when the gun is fired.—*November 29th*, 1905.

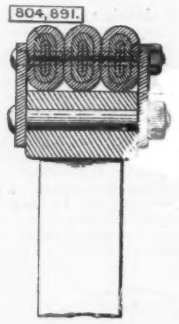
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

804,891. VEHICLE TIRE, *A. J. Slade, New York, N.Y.*—*Filed July 19th*, 1905.

This invention will be easily understood from the drawing.

804,891.

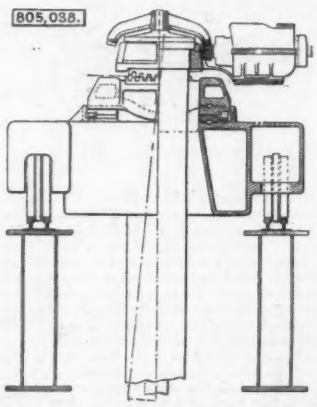


There are five claims. The tire consists really of canvas and rubber tubing, flattened as shown.

805,038. HYDRAULIC CRANE, *C. L. Taylor, Alliance, Ohio, assignor to the Morgan Engineering Company, Alliance, Ohio.*—*Filed October 8th*, 1904.

This is a patent for a forge crane. The invention consists in an

805,038.

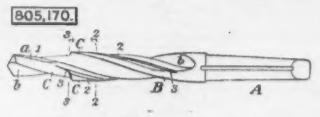


arrangement by which the cylinder with its piston and rod may be inclined from the vertical to augment its radius of action. The inclination is effected by causing the suspension sleeve to revolve on an inclined toothed path, an electric motor causing the revolution. There are nine claims.

805,170. BORING TOOL, *P. Thomas, New York, N.Y., assignor to H. R. Worthington, New York, N.Y., a Corporation of New Jersey.*—*Filed September 27th*, 1904.

This invention is best described by the fourth and last claim. A boring tool having the smaller portion C with spiral grooves *b* and

805,170.

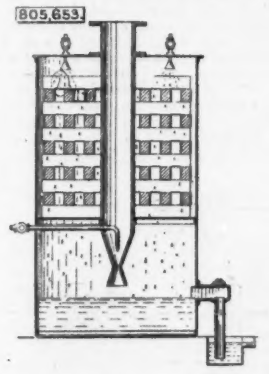


spiral edges 1 and larger portion B through which the grooves *b* and edges 1 extend, and which larger portion is provided with raised portions *c* having edges 2 and clearance grooves 3.

805,653. — APPARATUS FOR CLEANING MANUFACTURED GASES, *L. P. Lowe, San Francisco, Cal.*—*Filed March 10th*, 1902.

According to this invention, the gas enters through a central pipe, a steam jet being used to induce a flow. The discharge out-

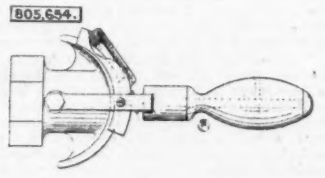
805,653.



let is at the top. A spray of water is maintained through the apparatus. The heavy portions or impurities and dust settle on the water, with which the light gas scarcely comes in contact. There is only one claim.

805,654.—SIGHT COCK FOR GAS FURNACES, *L. P. Lowe, San Francisco, Cal.*—*Filed June 17th*, 1903.

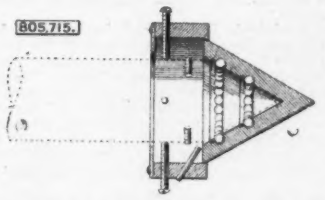
805,654.



The shield is curved, and slides over a curved seat. The shield carries a circular dark glass as shown. There are six claims.

805,715.—TURNING-LATHE CENTRE, *C. J. Dalley, Raritan, N.J.*—*Filed September 24th*, 1904.

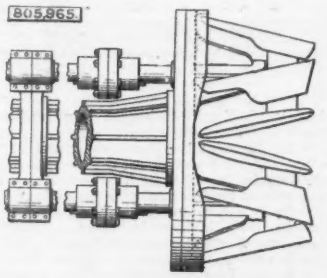
805,715.



A conical cap fitted with ball bearing is put on the lathe centre. There are five claims.

805,965.—DREDGING APPARATUS, *F. A. Jones, Houston, Tex.*—*Filed May 20th*, 1905.

805,965.



This patent is for the combination of cutters revolving in opposite directions with the mouth of the suction pipe of a dredger. There are eight claims, all for details.

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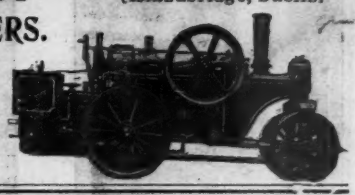

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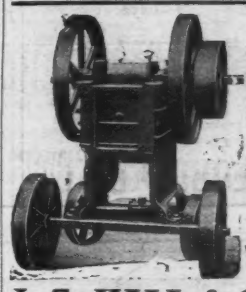

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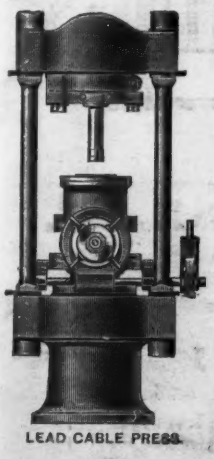

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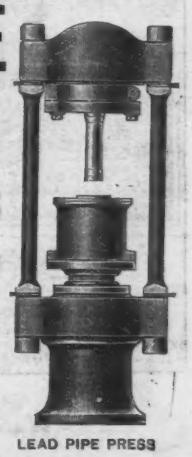

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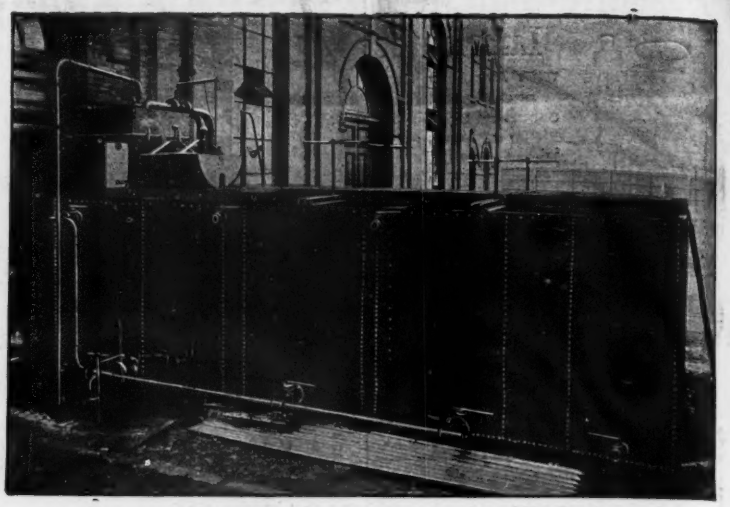

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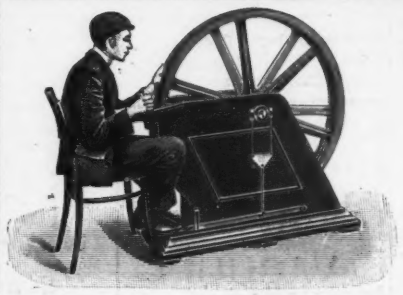

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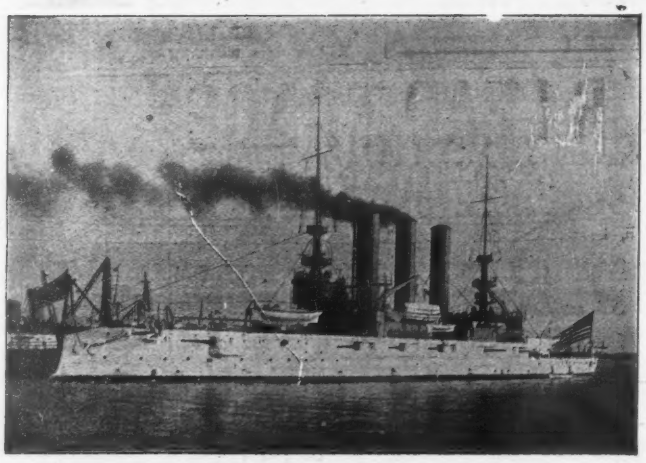

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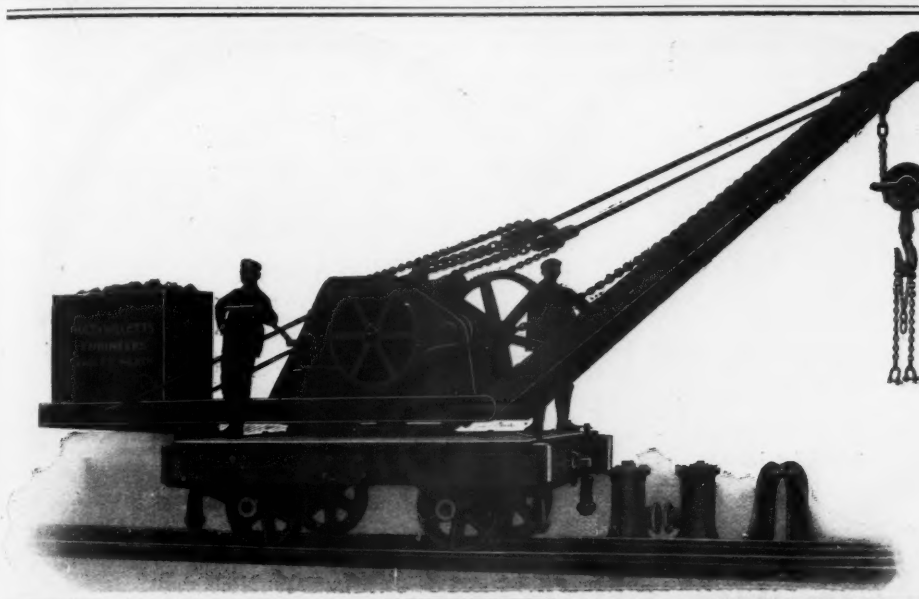

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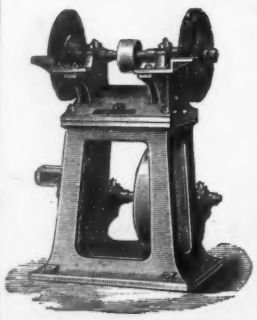

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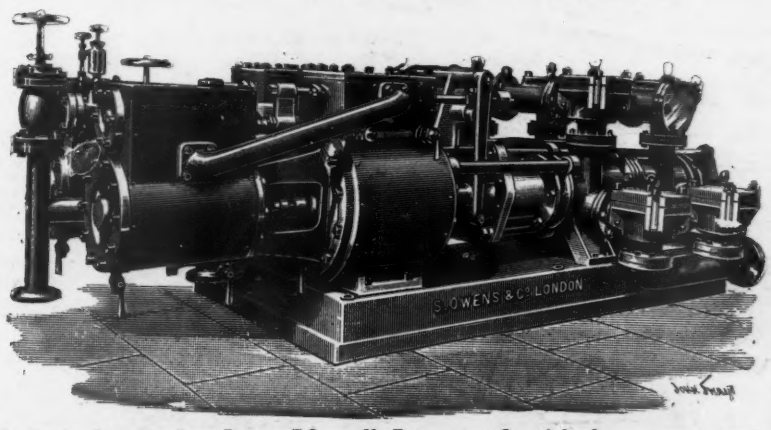

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